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Report No. CG-D-14-01

EVALUATION OF U.S. COAST GUARD'S PILOT SURVEY OF USERS OF NAVIGATIONAL AIDS IN TAMPA BAY, FLORIDA

FINAL REPORT
AUGUST 2001

Prepared for:

U.S. Department of Transportation
United States Coast Guard
Operations (G-O)
Washington, DC 20593-2100

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (FROM - TO)
01-08-2001	Final	xx-xx-2001 to xx-xx-2001

4. TITLE AND SUBTITLE
Evaluation Of the U.S. Coast Guard's Pilot Survey of Users Of Navigational Aids In Tampa Bay, Florida
Unclassified

5a. CONTRACT NUMBER
DTCG32-00-F-E00318; DTCG32-00-F-E00385

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Walker, Ric ;
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5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME AND ADDRESS
U.S. Coast Guard
Research and Development Center
1082 Shennecossett Road
Groton, CT06340-6096

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME AND ADDRESS
U.S. Department of Transportation
United States Coast Guard
Operations (G-O)
Washington, DC20593-2100

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
APUBLIC RELEASE
,

13. SUPPLEMENTARY NOTES
The R&D Center?s technical point of contact is Ric Walker (860) 441-2728, email: rwalker@rdc.uscg.mil or Kathleen Shea, (860)-441-2770, email: kshea@rdc.uscg.mil.

14. ABSTRACT
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15. SUBJECT TERMS
Coast Guard; navigation; aids to navigation; AtoN; short range aids to navigation; radio aids to navigation; user survey; program evaluation

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE	Public Release	90	Fenster, Lynn lfenster@dtic.mil
Unclassified	Unclassified	Unclassified			19b. TELEPHONE NUMBER International Area Code Area Code Telephone Number 703767-9007 DSN 427-9007

N O T I C E

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Technical Report Documentation Page

1. Report No.	2. Government Accession Number	3. Recipient's Catalog No.
CG-D-14-01		

4. Title and Subtitle	5. Report Date
Evaluation Of the U.S. Coast Guard's Pilot Survey Of Users Of Navigational Aids In Tampa Bay, Florida	August 2001
	6. Performing Organization Code Project No. 2420

7. Author(s)	8. Performing Organization Report No.
Ric Walker, Kathleen Shea and Sam Neill	R&DC 438

9. Performing Organization Name and Address		10. Work Unit No. (TRAIS)
U.S. Coast Guard Research and Development Center 1082 Shennecossett Road Groton, CT 06340-6096	U.S. Department of Transportation United States Coast Guard Office of Aids to Navigation (G-OPN) Washington, DC 20593-2100	11. Contract or Grant No. DTCG32-00-F-E00318 DTCG32-00-F-E00385

12. Sponsoring Organization Name and Address	13. Type of Report & Period Covered
U.S. Department of Transportation United States Coast Guard Operations (G-O) Washington, DC 20593-2100	Final Report
	14. Sponsoring Agency Code Commandant (G-OPN) U.S. Coast Guard Washington, DC 20593-2100

15. Supplementary Notes

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16. Abstract (MAXIMUM 200 WORDS)

This report describes the U.S. Coast Guard R&D Center's pilot survey and preliminary findings on the use of marine navigational aids (NavAids) in the Tampa Bay area of Florida. The Coast Guard R&D Center developed a web-based survey instrument to assess the navigational behaviors and preferences of NavAid users. Operators of commercial, public, military, and recreational vessels were solicited for their input by a pilot survey effort that was carried out during the summer of 2000. The preliminary findings indicate that mariners use nearly all navigational aids that are available to them. In general, as a mariner navigates from the open ocean to coastal areas, harbors and narrow channels, his/her reliance on NavAids progressively changes from radio aids like the Differential Global Positioning System (DGPS), to the Short Range Aids to Navigation, such as buoys and light structures, all provided by the U.S. Coast Guard. Inshore, mariners also rely on other NavAids such as geographic features and man-made structures. The results of the survey are used to assess the alignment of program services. Overall, the assessment revealed no clear areas of outdated or substantially misaligned services.

17. Key Words	18. Distribution Statement
Coast Guard, navigation, aids to navigation, AtoN, short range aids to navigation, radio aids to navigation, user survey, program evaluation	This document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161.

19. Security Class (This Report)	20. Security Class (This Page)	21. No of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED		

Form DOT F 1700.7 (8/72) Reproduction of form and completed page is authorized

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EXECUTIVE SUMMARY

The United States Coast Guard (USCG) maintains short range (mostly visual) and long range (radio) aids to navigation that guide mariners to safe waters and away from hazards. Recent developments in radio navigation, as well as technological developments in electronic charting and navigation system integration, provide additional services to mariners. As part of its broader research into aid mix and waterway risk management, the USCG Research and Development Center (RDC) developed a web-based survey to help understand how mariners are actually using navigational aids. This survey sought to identify what navigation information is required by mariners and how they use aids to navigation, particularly various combinations of short range and radio aids, and other navigational aids to acquire this information and guide their vessels.

A pilot test of the survey was conducted in Tampa Bay, Florida during the summer of 2000. A total of 698 responses were collected from several major maritime population segments: Commercial, Public/Military, and Recreational Vessel Operators. The survey questions were designed to gain a better understanding of user preferences for, and actual use of navigational aids as a function area of operation, visibility, and user group. The results of the pilot study were used to develop findings concerning navigational aid use, an assessment of program service alignment with user needs, and suggestions for improving the overall survey process.

The preliminary findings indicate that Tampa Bay mariners state that they use nearly all navigational aids that are available to them, over the range of conditions and areas in which they navigate. Both NavAid preferences and usage patterns vary with user group, area of operation, and visibility. Global Positioning System (GPS) technology has been widely accepted by all groups except the Small Port-based Fishing and Charter group. More than half of the operators in this group continue to rely on LORAN as their primary radio aid to navigation. The use of Differential GPS (DGPS) by Large Commercial and Public/Military vessel operators is significant, but is limited to one third or less of the operators in all other user groups. However, mariners in all user groups cited buoys and lighted buoys, in addition to GPS/DGPS as their most preferred NavAids. The use of short range and radio aids varies significantly with the area of operation. As users progress from the open ocean, through the near coastal area to port, there is a general shift in preference from radio aids to mixed preference (combinations of radio and short range aids) to short range aids as the primary source of information.

One purpose of this study was to compare user needs as expressed through the survey responses, to current services delivered by the program. Overall, the assessment revealed no clear areas of outdated or substantially misaligned services, although the report discusses some ideas for future program alignment, and the need for continued monitoring of user needs in an environment of rapidly changing technology.

As a result of this pilot study using the prototype survey instrument, several shortcomings in the overall survey process were identified: 1. lack of total population figures for the various user groups in the survey area; 2. small sample size for four of the six user groups; and 3. prototype survey questions need further development. These and other factors limit the validity of the findings drawn from the survey data. The specific findings in this report are therefore based on

trends and patterns observed in the data, which nonetheless provide some sense of mariners' preferences for, and use of, marine navigational aids.

The web-based AtoN User Survey instrument provides a prototype tool for gathering information to help understand mariners' needs for navigational aids. However, the results obtained in any single port may not be representative of NavAid preferences and use nationally. Experience suggests that there are five somewhat distinct areas in the country (Atlantic, Pacific, Gulf, Great Lakes and Western Rivers) that would require sampling to gather enough information to assemble a national picture.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

LIST OF ACRONYMS

AIS	Automatic Identification System
ARPA	Automatic Radar Plotting Aid
DGPS	Differential Global Positioning System
ECDIS	Electronic Chart Display and Information System
ECS	Electronic Chart Systems
G-OPN	Coast Guard Office of Aids to Navigation
GPS	Global Positioning System
IALA	International Association of Lighthouse Authorities
IMO	International Maritime Organization
LORAN	Long-Range Navigation
MI	Marine Information
NavAids	Navigational aids
NOAA	National Oceanic and Atmospheric Administration
OMB	Office of Management and Budget
RA	Radio Aids to Navigation
RACON	Radar Beacon
RDC	USCG Research & Development Center
RV	Restricted Visibility
SA	Selective Availability
SRA	Short Range Aids
TD	Time Difference

LIST OF ACRONYMS

USCG	United States Coast Guard
VTM	Vessel Traffic Management
WAAS	Wide Area Augmentation System
WAMS	Waterways Analysis and Management System

EVALUATION METHODOLOGY

BACKGROUND

The U.S. Coast Guard maintains short range (mostly visual) and long range (radio) aids to navigation that guide mariners to safe waters and away from hazards. These services are designed to minimize collisions and groundings and enable the efficient and effective movement of military, commercial and recreational vessels through waterways. The resulting, commercial, military/government, and recreational use contributes substantially to our economic vitality, security, and quality of life.

Recent developments in radionavigation, such as the Differential Global Positioning System (DGPS) and the removal of selective availability from the Department of Defense's Global Positioning System (GPS), as well as technological developments in electronic charting and navigation system integration, provide additional services to mariners. As part of its broader research into aid mix and waterway risk management, the USCG Research and Development Center (RDC) developed a web-based user survey. The survey is intended to help the Coast Guard's Office of Aids to Navigation and Marine Information (G-OPN) understand how these aids to navigation and other navigational aids are actually being used. An assessment of program services and how they align with user preferences as characterized by the survey findings may reveal ways to manage the Coast Guard's AtoN system resources more effectively, while maintaining an acceptable level of safety, mobility, security and protection of natural resources.

One element of USCG Research & Development Center's research (RDC's) effort was the design and execution of a pilot survey of mariner behavior and preferences in navigation. This survey sought to identify what navigation information is required and how mariners use aids to navigation, particularly various combinations of visual and electronic aids, and other navigational aids available to them. Data and expert opinion collected from a complete array of user groups were analyzed to derive user requirements. Extracts from "Report of Results, Pilot Survey of Aids to Navigation (AtoN) Users Conducted in the Tampa Bay, Florida Area, Summer 2000," can be found as Appendix A.

This pilot survey serves two useful purposes:

- The intended purpose for the pilot survey was to develop an improved survey for delivery in a wider range of ports. Such a survey could identify user preferences and behavior patterns for use in risk modeling of waterways.
- Taken on its own, the pilot survey offers a potentially useful "spin-off" benefit to the G-OPN as a process evaluation. The survey was designed to draw out user needs independent of current service provision as well as to draw out user preferences between existing services. This has the potential to provide a useful benchmark of customer preferences and behaviors against which to compare current program design and activities.

This summary report serves the second of these two purposes. It evaluates the patterns of preferences and use that emerge from the data in Appendix A for the purpose of comparing these patterns to current program delivery.

Special Note: For clarity, an ***aid to navigation*** or AtoN is defined as a device external to a vessel designed to assist in determination of position, a safe course, or to warn of dangers or obstructions. Coast Guard short range and radio aids to navigation fall in this category. The term ***navigational aid*** or NavAid, is a broader expression covering any instrument, device, chart, method, etc used to assist in the navigation of a vessel. This evaluation will use these terms in these contexts.

METHODOLOGY

A process (or implementation) evaluation assesses the extent to which a program is operating as it was intended. It typically assesses program activities' conformance to statutory and regulatory requirements, program design, and professional standards or customer expectations.
The U.S. Coast Guard programs under consideration in this evaluation are the short range and radio aids to navigation programs. Table 1 provides a program logic model to describe the short range and radio aids to navigation program elements and their desired ends.

TABLE 1: Logic Model for Short Range and Radio Aids to Navigation Programs

Program Goal(s)	Program Outcomes	Activity Output	Program Activities	Resources
What goal is the Coast Guard trying to achieve?	What must occur as a result of USCG products and services?	What must be produced from USCG activities?	Specifically, what USCG activities must be performed?	What resources are available to the program?
1. Reduce deaths, injuries, loss or damage of property, marine pollution and disruptions to maritime commerce related to vessel navigation.	1. Foreign and U.S. vessels navigate efficiently through U.S. waterways without groundings, allisions with fixed objects or collisions with other vessels.	1. Short range aids to navigation systems (within design specifications) and with a reliability goal of 99.7% or greater. 2. LORAN-C signal within design specifications and coverage; and with a single station reliability goal of 99.9% or greater and a chain reliability goal of 99.7% or greater. 3. DGPS signal within design specifications and coverage; and with a single coverage availability goal of 99.7% or greater and a dual coverage availability goal of 99.9% or greater.	1. Design effective systems consistent with international standards for aids to navigation. 2. Establish, maintain, and operate short range aids to navigation (visual aids, radar transponders (RACONS) and sound signals). 3. Establish, maintain, and operate radio aids to navigation (LORAN-C and DGPS). 4. Disseminate information about the operation and status of short range and radio aids to navigation. 5. Periodically evaluate the effectiveness of systems and adjust as necessary.	1. Authority to establish and maintain aids to navigation 2. Coast Guard Buoy Tenders, Aids to Navigation Teams (ANTs), Groups, Coast Guard Auxiliarists. 3. LORAN-C Stations, DGPS Stations, Coast Guard Navigation Center (NAVCEN). 4. Program Managers (i.e. District, Area, and HQ units, etc.) 5. Real property, capital assets and Coast Guard support elements. 6. References (i.e. policy documents, documented procedures, international conventions, U.S. regulations, etc.)

U.S. Coast Guard Vessel Traffic Management (VTM), Marine Information (MI), Domestic Icebreaking, Licensing and Regulation programs also aim to influence the same outcome -- the safe and efficient movement of vessels – but were not addressed in the scope of this survey and evaluation.

Appendix A provides the results of an Office of Management and Budget (OMB) approved pilot survey of mariners in the Tampa Bay, FL, area. The objective of this process evaluation is to use these survey results in assessing the match between program activity outputs and self-reported user preferences and behaviors. The evaluation seeks to answer four questions:

- What is the profile of users of aids to navigation (vessel types, mariner training, areas of operations, and conditions of visibility)?
- What are self-reported preferences between Coast Guard services provided?
- What are self-reported navigational fix frequency and accuracy requirements, independent of Coast Guard service provision?
- Do any patterns emerge that suggest an alignment or misalignment of Coast Guard services?

To answer these questions, the data in Appendix A are analyzed for significance and presented along different dimensions in order to identify either significant results or patterns worth consideration and further study.

OVERVIEW OF PROGRAM ACTIVITIES AND SERVICES

U.S. Coast Guard short range aids to navigation and radio aids to navigation services work together to safely guide the mariner through U.S. waterways. The following is a summary of these services provided in Tampa Bay, FL.

Short Range Aids to Navigation consist of buoys, beacons, lights, lighthouses, ranges, sound signals (fog horns, bells, etc.), and radar-reflecting devices that mark navigable channels and obstructions to safe navigation. The purpose of these aids is to assist mariners and boaters in determining their position and safe course, warn them of dangers and obstructions, and promote safe and economic movement of vessel traffic.

The Tampa Bay area centers around a large natural bay that extends Northeast into the Gulf Coast of Florida for about 20 miles, and is 6-7 miles wide. It is the approach to the Manatee River, Boca Ciega Bay, Old Tampa Bay, and Hillsborough Bay, and to the cities of St. Petersburg, Port Tampa, East Tampa, Bradenton, Port Manatee, and Tampa. A Federal project provides for a main channel with depths of 45 feet in the entrance from the Gulf, thence 43 feet to Tampa and 34 feet to Port Tampa. Egmont Channel is the main ship channel, and is used by all deep-draft vessels entering Tampa Bay. Dredged cuts lead up the bay through Tampa Bay, Hillsborough Bay, and Old Tampa Bay to Port Manatee, Big Bend, Alafia River, Port Sutton, Tampa, Port Tampa, and Weedon Island. Lighted ranges, and lighted and unlighted buoys serve these channels. The area is also served by the Gulf Intracoastal Waterway, which follows the coastline across the lower part of Tampa Bay. Other, smaller channels serve recreational harbors and traffic associated with Tampa Bay.

Approximately 460 Federal buoys, lights, and beacons serve the waters in the area of Tampa Bay and the nearby Intracoastal Waterway. These are provided by the U.S. Coast Guard in conformance with the International Association of Lighthouse Authorities (IALA) marking scheme "B," which calls for lateral aids to navigation of a specified color and design. The placement of the aids is governed by U.S. Coast Guard waterway design standards and Waterways Analysis and Management System (WAMS) evaluations. A similar number of private aids to navigation serve the general area of Tampa Bay, and are regulated by the U.S. Coast Guard to ensure that they are in conformance with national standards. Approximately 33 pairs of range structures serve the deep draft and other channels in the Bay. There is one lighthouse and one RACON (aid to navigation with a radar transponder) that serve this area. There are no sound signals (such as fog horns) in the Tampa Bay area.

Tampa Bay is served by a Vessel Traffic Advisory System operated by the Tampa Port Authority Operation Department. This system helps masters, pilots, and persons in charge of vessels determine the safest location for meeting or passing other vessels in Tampa Bay. Operations focus on larger commercial vessels using the main shipping channels. In 1999 the Army Corps of Engineers logged approximately 4,500 port calls (or about 9,000 transits) to Tampa Harbor and Port Manatee by foreign and domestic commercial vessels of 500 or more gross tons. The draft of these vessels ranged from 18 to 40 feet.

Radio Aids to Navigation consist of Long Range Navigation (LORAN-C), Global Positioning System (GPS) and Differential Global Positioning System (DGPS). The Coast Guard provides LORAN-C and DGPS services; the Department of Defense provides GPS service. The purpose of these systems is to provide continuous, accurate, all-weather positioning capability to navigators of both vessels and aircraft, in order to prevent disasters, collisions, and wrecks.

The Tampa Bay area is served by the 7980 (Southeast U.S.) LORAN-C Chain. The system allows mariners, aviators, and terrestrial users to determine their position to an accuracy of approximately one-quarter nautical mile. This level of performance meets maritime standards for the coastal and ocean phases of navigation as defined in the 1999 Federal Radio Navigation Plan.

Without enhancements, GPS coverage of the Tampa Bay area allows mariners, aviators, and terrestrial users to determine their position to an accuracy of approximately 20 meters.[1] This level of performance meets maritime standards for the coastal and ocean phases of navigation

DGPS augments GPS using a system of land-based radiobeacons. A radiobeacon at MacDill, FL serves users in the Tampa Bay area, improving the accuracy of GPS and, more critically, providing a warning to users of any detected faults in the GPS service through integrity monitoring. This service allows mariners and terrestrial users to determine their position to an accuracy of better than ten meters, and typically better than three meters depending on distance from the DGPS station and quality of the user's receiver. This level of performance meets maritime standards for the harbor entrance and approach phases of navigation.

[1] By Presidential Decision, GPS Selective Availability (SA) was turned off on 2 May 2000, increasing GPS accuracy. DOD is currently refining accuracy standards for non-SA GPS. 20 meters is a generally accepted estimate at this time.

OVERVIEW OF SURVEY DESIGN

As part of its broader research into aid mix and waterway risk management, RDC developed a web-based survey instrument to assess navigational behaviors and preferences of AtoN users. Appendix A provides the results from a pilot test of the survey in Tampa Bay, Florida, conducted during the summer of 2000.

The goals for the AtoN User Pilot Survey were to:

- Collect information on mariners' use of AtoN (short range and radionavigation aids provided by the Coast Guard, as well as other references available to the mariner)
- Identify AtoN user preferences under a range of conditions
- Identify the impacts of emerging AtoN technologies such as GPS/DGPS, and
- Determine the nature of information that can be extracted, and the potential for applying the survey results on a national basis.

The pilot survey was targeted to reach as many of the NavAid users in the Tampa Bay area as possible. This contained several major population segments: Commercial, Public/Military, and Recreational Vessel Operators. A total of 698 responses were collected as a result of 3281 targeted mailings. Of the total responses, 641 were usable for analysis, which gave a response rate of 19.5 percent. See Table 1 in Appendix A for details.

Data are available from the pilot survey on several vessel characteristics, including length, beam and draft, as well as average and maximum transit speeds. See Table 2 in Appendix A for details. Respondents were asked whether they held a USCG license, as well as their years of experience as mariners. See Table 3 in Appendix A for details. Finally, respondents were asked about the nature of the waterways in which they operate (ocean, coastal, harbor, channel, inland) and the range of visibility conditions they encounter (day, night, restricted) when using each of these waterway types. See Table 4 in Appendix A for details.

The user groups and the specific vessel types associated with them were developed as part of the original survey design. Preliminary analysis of the responses suggested that the original user groups could be more effectively organized. With regrouping, the data provided more useful insights into mariner demographics, vessel characteristics, position fix frequency and accuracy, and NavAid importance and preferences under several operating conditions, for each user group. The final user groups are generally categorized by vessel type and the nature of their operation and are described in the following section.

STATISTICAL SIGNIFICANCE

As a result of this pilot study using the prototype web-based survey instrument, several shortcomings in the overall survey process were identified;

- Lack of total population figures (or exposure/use) for the various user groups in the survey area
- Small sample size (< 20) for four of the six user groups

- Prototype survey questions need further development

The validity of the findings drawn from the survey data is limited by these and other factors. For the pilot survey the specific statistical tests and questions or hypotheses to be addressed by the data were not developed in advance. As such, there was insufficient guidance to determine appropriate sample sizes to ensure statistical adequacy. The specific findings presented in this report are therefore based on trends and patterns observed in the data, and are interesting in their own right. However, it is essential to note that in several cases they are based on a small sample size which may not be statistically adequate. Additionally, any findings based on the total population will generally be biased toward the responses of recreational boaters, due to their high rate of participation in the survey and their proportionally large number within the overall population. Wherever possible, data such as raw counts for individual group results were normalized by the group population and presented as percentages, to avoid misrepresenting the information on groups with wide variances in the total number of responses. These findings also pertain only to the users in the Tampa Bay survey area. While the types of users in Tampa Bay are not untypical of U.S. waterways, this survey is not sufficient in itself to establish national trends due to such things as regional variations in weather, hydrography and marine traffic.

Presentation and Evaluation of Findings

The findings are presented as responses to a series of general questions regarding the mariners that use NavAids, how they use NavAids, what aid types they prefer, and the variances due to location and condition.

I Profile of Survey Respondents

The following user groups were developed for the purposes of this survey.

Group 1: Large Commercial Inter-port Vessels with Pilots. These vessels, such as tankers, cruise-liners and container ships, are ocean-capable and are navigated in the port area with the assistance of a certified harbor pilot. Their size, lack of maneuverability and cargo make avoidance of incidents a top USCG priority. Responses from harbor pilots who are not associated with any specific type of vessel have also been included in this group. This group provided **12** responses to the survey. While this response level is too small to characterize this group with statistical significance, it is noteworthy that 8 respondents were Tampa Bay Pilots, out of a population of 30. According to Chapter 310 in the Florida Statutes, pilotage is compulsory in Tampa Bay for most large commercial vessels. Because of this, Tampa Bay pilots represent a dominant and recurring commercial user of aids to navigation. So the pilot responses give data from Group 1 particular relevance in describing the needs and preferences of the high-end commercial user.

Group 2: Other Commercial Port-based Vessels. These vessels are typically smaller commercial vessels such as ferries, harbor cruises, tugs etc., and operate out of a single port. In general, they do not require pilot assistance in harbor navigation. This broad category captures diverse commercial users who nevertheless share similar capabilities and operating profiles. This

group provided **14** responses. This response level is considered too small to provide a statistically sound characterization of this group.

Group 3: Commercial Port-based Fishing Vessels. These are ocean-capable commercial fishing vessels, such as gillnet, trap and trawlers, but they operate out of a single port. They do not take on a pilot for harbor channel navigation, and most do not need to navigate the harbor within the marked shipping lanes, due to the small size and shallow drafts that characterize these vessels. This group provided **12** responses, evenly distributed between Gillnet, Trap and Trawl vessels. This response level is considered too small to provide a statistically sound characterization of this group.

Group 4: Public/Military Inter-port Vessels. Many of the public (state, research) and military (Coast Guard in Tampa) vessels in this group may be port-based, but most are generally capable of operating in the open ocean. While not necessarily required by federal regulations, larger vessels in this group may take on a pilot for harbor navigation. Some of these vessels share characteristics with the vessels included in Group 2. This group provided **18** responses. This included six United States Coast Guard cutters and six state vessels. This response level is considered too small to provide a statistically sound characterization of this group.

Group 5: Small Port-based Fishing and/or Charter Vessels. Operators of these smaller vessels make up the largest group of commercial mariners in this survey. Vessels in this group most frequently carry passengers for hire (charter) or conduct light commercial fishing (hook and line). They provided **68** responses. This response level is considered of sufficient size to provide a more meaningful characterization of this group.

Group 6: Recreational Vessels. These include motor-, sail-, and human-powered vessels, which are generally smaller vessels. Operators of vessels in this group often exercise discretion by avoiding bad weather or darkness. Operator experience and equipment carriage varies widely, but generally, this group includes users with the least training and least equipment. This group contained the largest number of respondents, with **517**. This response level is considered of sufficient size to provide a statistically meaningful characterization of this group.

Who has Coast Guard Licenses?

- Virtually all of the Large Commercial Inter-port Vessels with Pilots (Group 1) respondents and most of the Other Commercial Port-based (Group 2) respondents reported having USCG licenses.
- Twenty-five percent of the Commercial Port-based Fishing Vessels (Group 3) and eleven percent of the Public/Military Inter-port Vessel (Group 4) operators had USCG licenses. While the percentage of commercial licenses for operators in Group 4 is low, the military bridge crews are generally highly trained and possess skills comparable to licensed mariners.
- Operator license-holding in the Small Port-based Fishing and/or Charter Vessels (Group 5) varies between the subgroups. While very few hook & line vessel operators have licenses (as is the case for the gillnet, trap, and trawler fishing boat operators), at least half of the charter and fishing charter boat operators, who generally carry passengers for hire, reported having a USCG license.

- Recreational boaters (Group 6) are not licensed by the Coast Guard. Recreational boaters who hold a CG license for another purpose were encouraged to answer as a member of the user group representing that type of operation.

How does the area of operation vary with user group?

Areas of vessel operation were classified into five specific types of waterways:
- Narrow Channel (channels generally maintained for deep draft vessels)
- Inland (Intracoastal Waterway, canals, rivers)
- Harbor (Including harbor approaches, lakes, bays, and sounds)
- Near Coastal (within 25 miles from shore)
- Open Ocean (more than 25 miles from shore)

This list represents a continuum of waterways that are progressively less constrained for navigation. It is also worthwhile to note that not all NavAids are available in all waterways. For example, range marks are used to mark narrow channels and some narrow inland waterways, and there are no short range aids in the open ocean.
Data on which user groups operate in what areas are shown in Figure 1.

- All groups reported frequent use of narrow channels, harbors, and near coastal areas.
- Variations in use among the groups were noted in the inland and open ocean areas. Other Commercial Port-based Vessels (Group 2) was the only group in which more than 50 percent of the respondents reported using inland areas. The same group showed the smallest use of the open ocean at less than 30 percent. This is consistent with the nature of operations for small passenger vessels (ferries, harbor cruises, tours, etc) that are subject to Subchapter T regulations. Respondents from all other groups indicated that 50 percent or more spent some time operating in open ocean areas.
- Looking across all user groups in the Tampa Bay data sample, narrow channels, harbors, and near coastal areas are used most frequently, and inland areas are used the least.

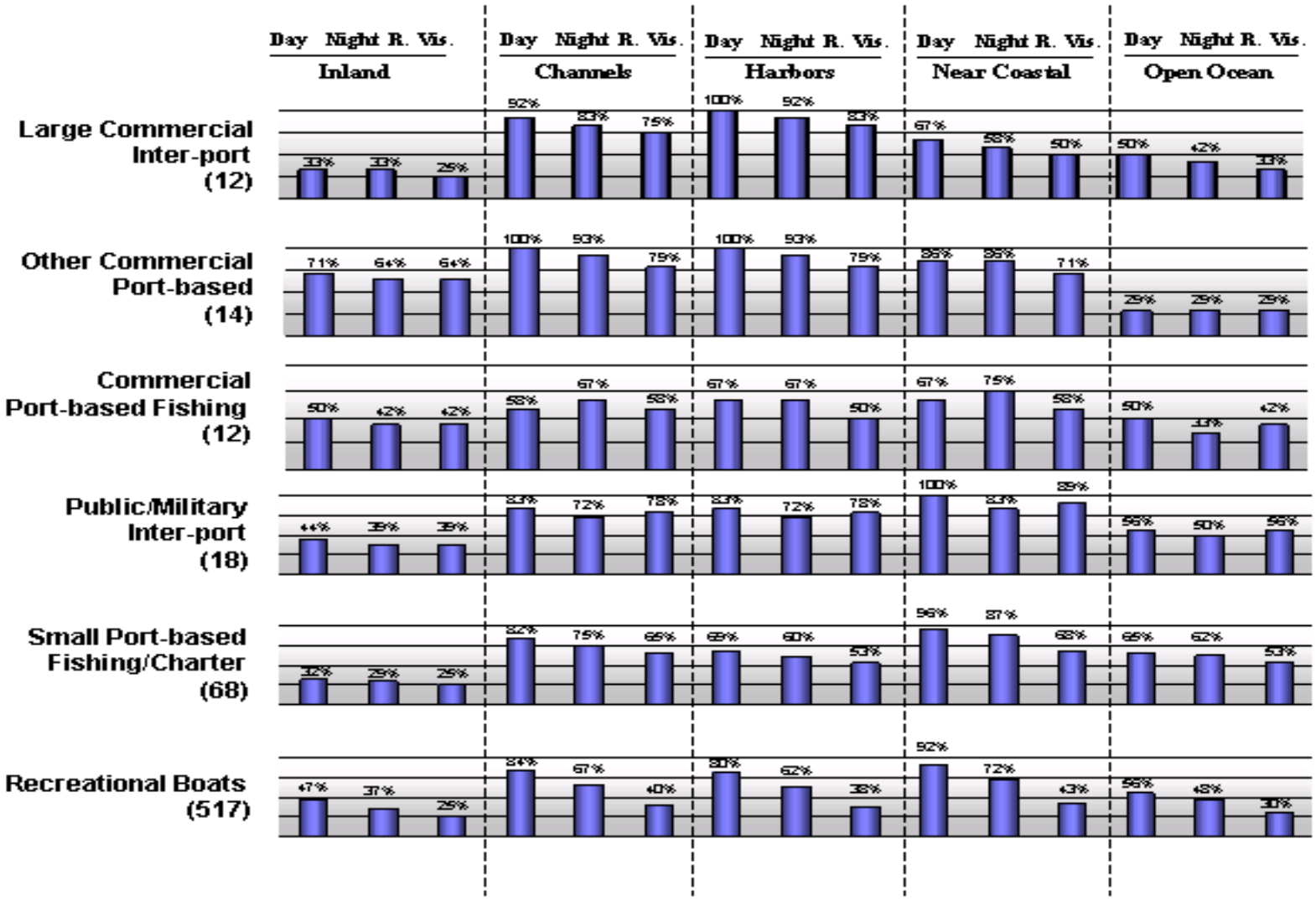
Who operates at night or in restricted visibility?

Visibility conditions were classified into three categories: day, night and restricted visibility (R.V.) "Restricted visibility" is any condition in which visibility is restricted by fog, mist, snow, rain, sandstorm or other similar cause. The data are presented in Figure 1. While interesting, the differences between the user groups presented below are not statistically significant.
- All groups operated less in restricted visibility compared to daytime.
- All groups except the Commercial Port-Based Fishing Vessels (Group 3) operated less at night than in daytime.
- Large Commercial Inter-port Vessels with Pilots (Group 1), Other Commercial Port-based Vessels (Group 2), Small Port-based Fishing and/or Charter Vessels (Group 5), and Recreational Vessels (Group 6) all reduced operations at night and further reduced operations in restricted visibility.
- Commercial Port-Based Fishing Vessels (Group 3) operated as frequently or more frequently at night in harbor, narrow channel and near coastal areas as compared to daytime operation. This group did reduce operations in inland and open ocean areas at night.

- Public/Military Inter-port Vessels (Group 4) generally operated less at night than in daytime or restricted visibility.
- Recreational vessels (Group 6) showed the most significant reduction in operations for both night and restricted visibility. This is consistent with the recreational nature of their operation and, in general, a lower level of training, experience and equipment to deal with these conditions.

As a generalization, the three-visibility groupings in Figure 1 give an indication of tolerance or avoidance of progressive increases in navigational risk (day to night to restricted visibility). Where the three bars trend downwards from left to right, there is either an industry practice or discretionary behavior that avoids navigational risk. The steeper the trend, the more pronounced the avoidance. Where the three bars remain more or less even there may be more tolerance of risk, either out of economic necessity or as a result of training and equipment carriage.

Figure 1. Navigation Area and Conditions of Operation by User Group



What navigation equipment is carried and what navigation equipment is used?

Equipment counts are based on the 641 useable responses from the survey participants in all groups. Since these observations are based on data across all groups, they may be biased toward the recreational boater. The data presented in Figure 2 show the percentage of all respondents that carry specific navigational aids, and the percentage of all respondents that use the navigational aid.

- The data in Figure 2 suggest the navigation equipment may be subdivided into three subgroups based on carriage and use as follows:

  Group I consists of the most basic and essential equipment for navigation and safe operation. This equipment is carried and used by 60 percent or more of the survey participants. In rank order these items are:

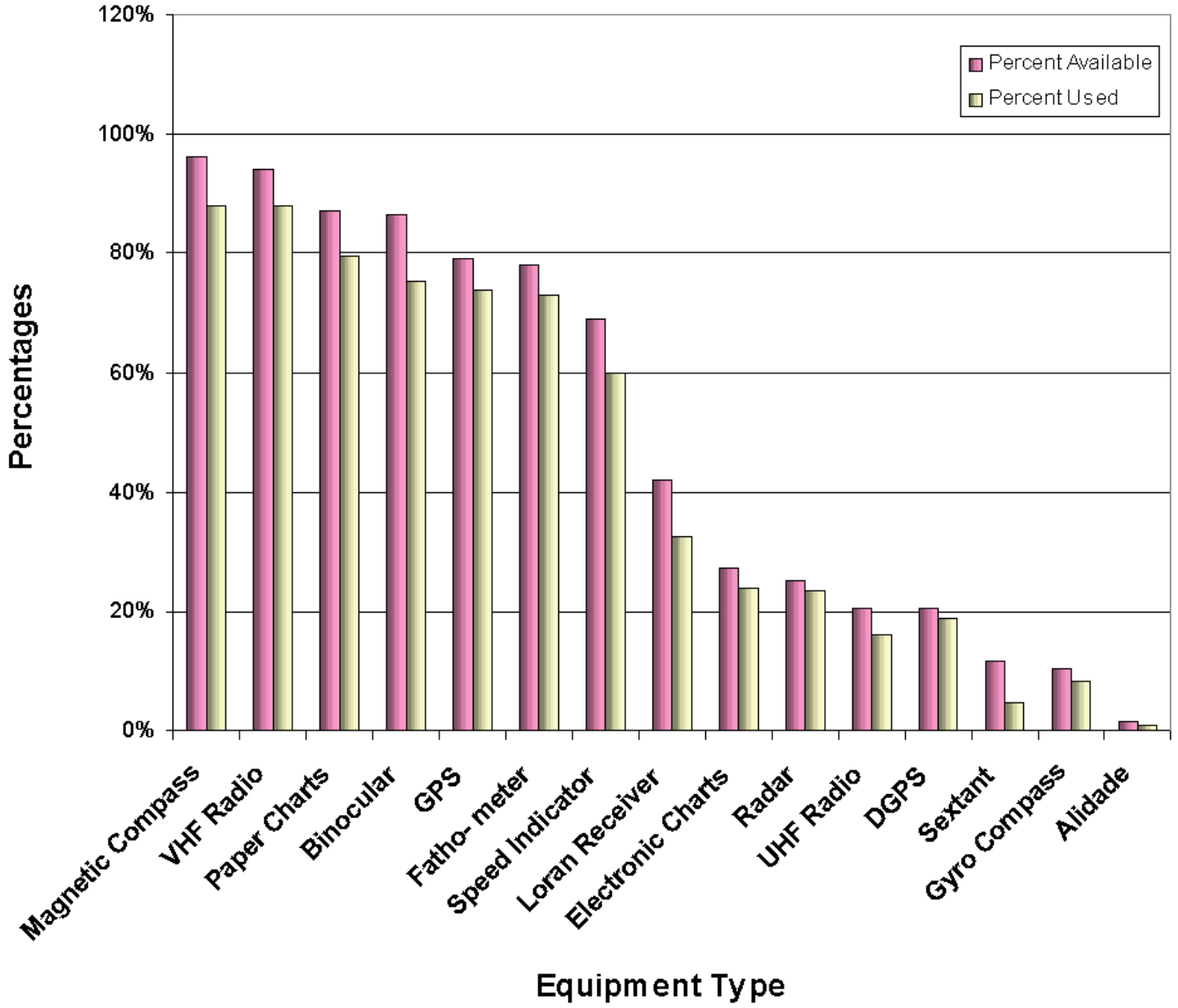
  1. Magnetic compass
  2. VHF radio
  3. Paper charts
  4. Binoculars
  5. GPS
  6. Fathometer
  7. Speed indicator

  Group II consists of navigational equipment more suited for the advanced or commercial user. The LORAN receiver may be an exception to this general description. It may have been more common in the past, but appears in this group now due to declining availability and use. This decline may be attributed to the introduction of GPS and its related services. LORAN usage remains high among small fishing vessels, probably due to the established repeatability of LORAN-C in locating preferred fishing "spots." The removal of Selective Availability (SA) from GPS occurred three months before this survey was conducted, and its full impact may not yet be apparent in these numbers. LORAN may see continued use as an effective backup should GPS/DGPS fail, but given the low availability of new marine receivers, one can expect standalone use of LORAN for marine navigation to decline unless new receivers are placed on the market. The introduction of the Wide Area Augmentation System (WAAS) for GPS provides an alternative source for differential information and may have an impact on the future carriage and use of DGPS within certain vessel groups. The carriage and use rate of Group II equipment ranges from about 40 percent to slightly less than 20 percent. The rank order of equipment in this group follows:

  1. LORAN Receiver
  2. Electronic charts
  3. Radar
  4. UHF Radio
  5. DGPS

  Group III consists of the least common equipment. Less than 12 percent of the survey population carry or use a sextant, gyrocompass or alidade. Commercial vessels of 500 gross tons or more are required to carry a gyrocompass. Military vessels are also likely to have a gyrocompass, but carriage by other user groups is extremely limited. The sextant appears to be carried as a backup for other navigation methods as more than 60 percent of those that carry one, do not use it. Less than 1.5 percent for the survey population carry and use an alidade.

Figure 2. Navigational Aid Equipment Availability and Usage Rates



- 171 respondents indicated they carry electronic charts. This number is slightly over one quarter of the number of respondents that carry either GPS or DGPS. The number of respondents that *use* electronic charts (153) is also one quarter of the number of respondents that *use* either GPS or DGPS. Carriage and use of electronic charts is expected to rise as they become more available, particularly the official vector charts currently being built by NOAA. When combined with an IMO compliant Electronic Chart Display and Information System (ECDIS), these charts will satisfy the federal requirements for chart carriage on commercial vessels. At that point, carriage of paper charts may drop, as mariners take advantage of the electronic chart option. To be fully effective, ECDIS and other Electronic Chart Systems (ECS) require the input of precise positioning information. As a result, carriage of GPS/DGPS is likely to rise along with ECDIS/ECS. Although developed separately, it is the integration of these products that will provide improved navigational capability for mariners.
- Survey data reveal recreational vessel GPS carriage to be 77 percent. Appendix A reports recreational use of GPS at 69 percent. This is significantly greater than the results of the 1998 National Recreational Boating Survey, which suggested that only 12 percent of recreational boat owners carry a GPS. The difference in carriage may be attributable to the sample frame of these surveys. The National Recreational boating survey queried all users nationally, including a significant number of smaller, inland (lake and river) boaters. The much greater intensity of GPS carriage and use in Tampa Bay is noteworthy, and much more relevant in evaluating Coast Guard aids to navigation programs, which serve predominately coastal users similar to this survey population.
- The majority (80 percent) of items carried are *used* by more than 80 percent of those that carry them. The most used items are the same and have the same rank order as the most carried items (see Figure 2). This is a good indication that users do not carry equipment, either as a result of regulation or free choice that they do not use.

II Position Information Frequency and Accuracy

How does the need for position information frequency and accuracy vary with the area of operation?

The survey asked respondents, "How often and how accurate do you require information about your vessel's position?" Figures 3 and 4, and Tables 6A and 6B in the Appendix, show the desired frequency and accuracy of vessel position information respectively, for those respondents who operate in all areas. The legend for each figure indicates the discreet choices that were available, ranging from once a minute to hourly.

The survey instructions encouraged respondents to answer the questions with respect to a "navigationally challenging" situation. During the development of the survey mariners suggested that "constantly" should be added as a selection to recognize fix frequency more often than once a minute. "Constantly" was added to the full pilot survey, but as a result, "constantly" dominated in all areas except the open ocean. A likely explanation for this behavior in the survey is that most of the respondents in vessel groups two through six likely interpreted this question in relative vessel position terms, rather than in absolute vessel position terms. In other words, these mariners probably used their selected NavAids to *judge* their position relative to the

channel or dangers rather than *fix* their position on a chart. Furthermore, mariners using electronic chart systems integrated with a position sensor are always plotting their position constantly. The effect of adding “constantly” seems to have been to “draw” respondents to this choice rather than to force consideration of a range of needs. To facilitate this analysis and correlation of position information frequency with waterway type, the constantly responses were omitted.

- After eliminating the "constantly" category, a predictable correlation between position information frequency and area of operation emerged.
  - Users require position information most frequently in narrow channels
  - Users require position information least frequently in the open ocean
  - User requirements for position information are similar in Inland and Harbor areas.
  - In general, the more constrained the waterway is, the more frequently users require position information.
- There is a similar correlation between position information accuracy and type of waterway.
  - Users require the most accurate position information in narrow channels
  - Users require the least accurate position information in the open ocean
  - User requirements for position accuracy are similar in Inland and Harbor areas.
  - In general, the more constrained the waterway is, the more accurate are users’ requirements for position information.

Figure 3. Position Information Frequency

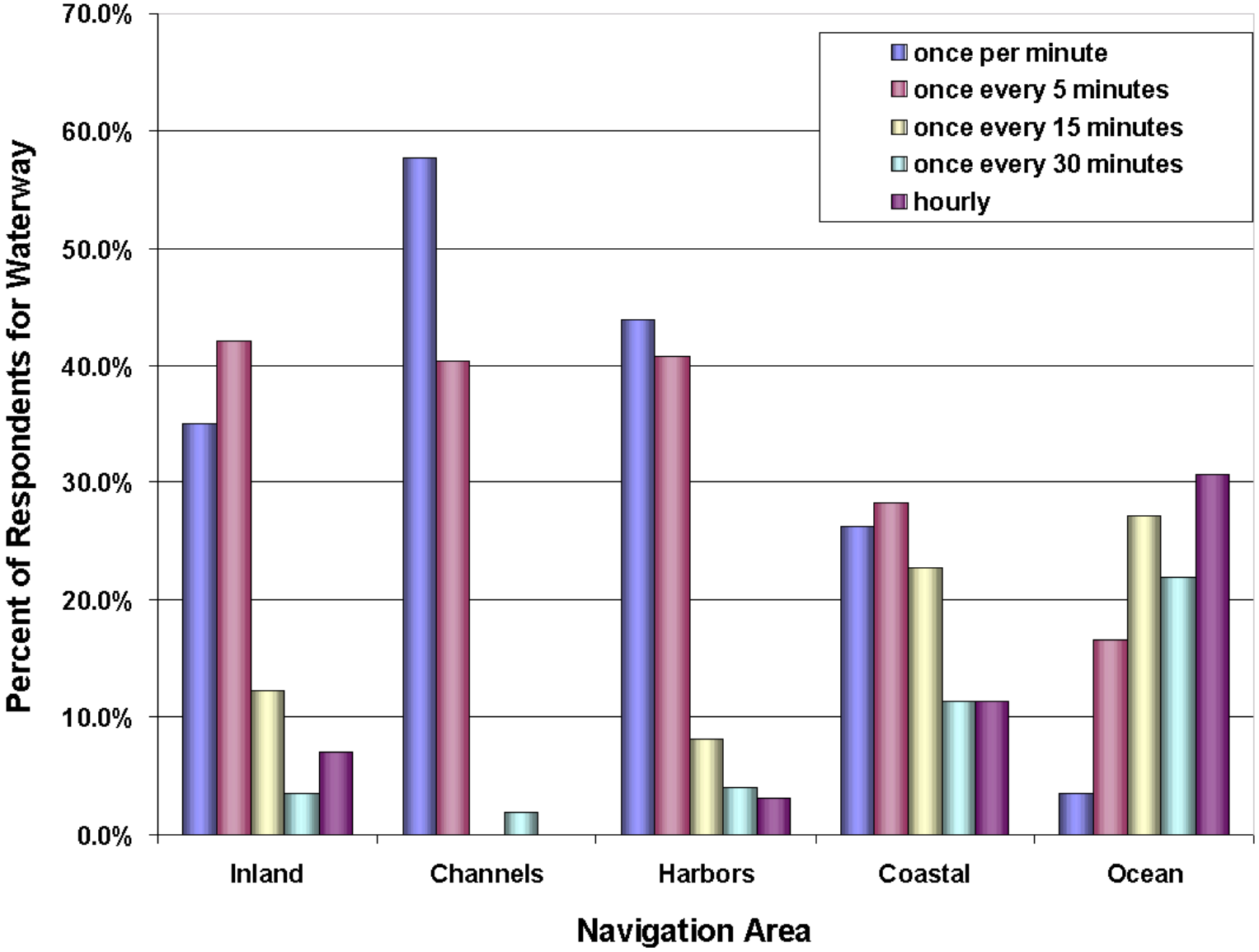
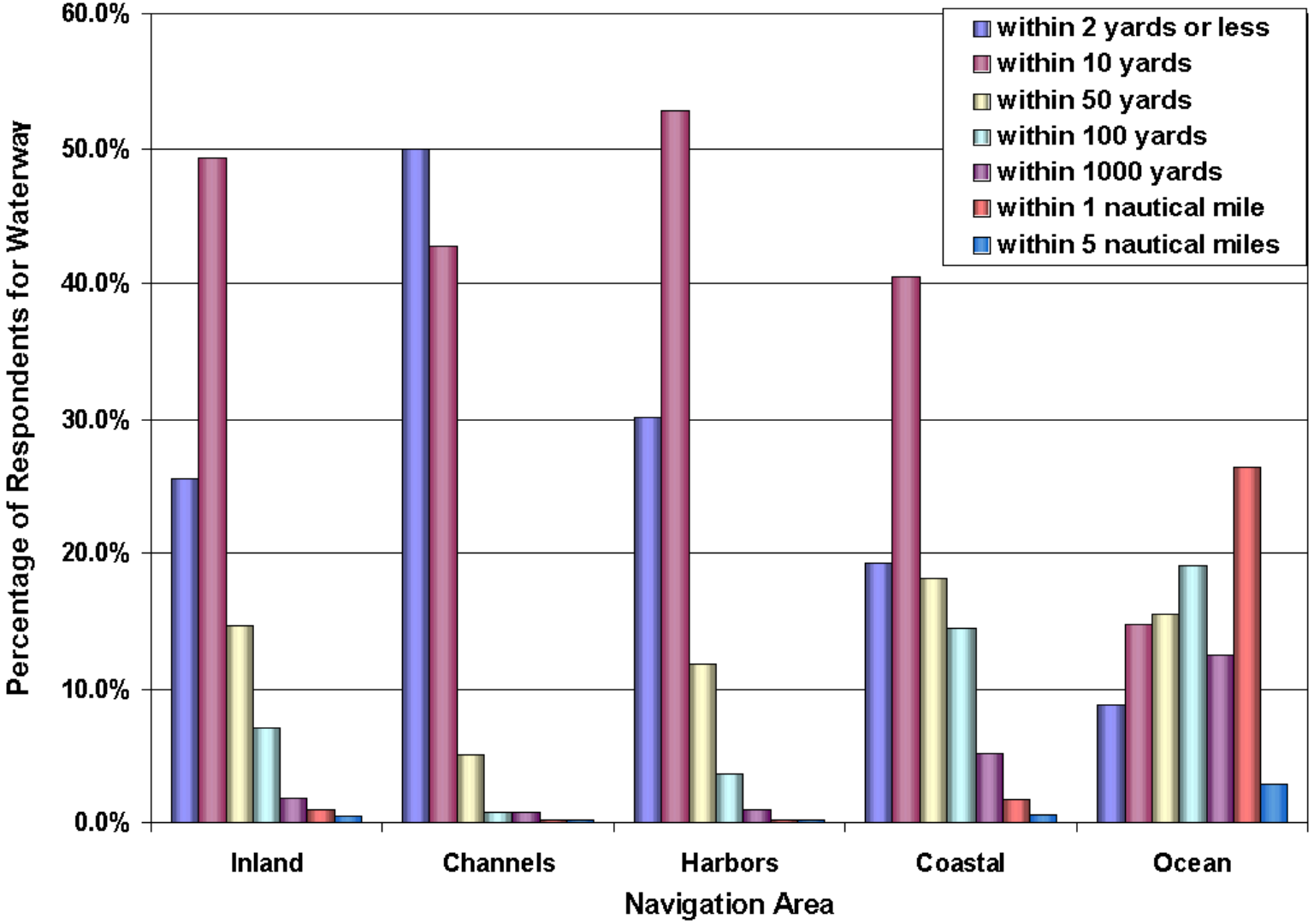


Figure 4. Position Information Accuracy



III Navigational Aid Preferences and Use

How do aid preferences vary with the area of operation?

Navigational aids generally fall into one of three categories: short range aids (SRA), radio aids (RA), and other (i.e., non-USCG) aids. See Figure 5. The data that are presented in this figure represent users who indicated that they operate in all the navigation areas. To help distinguish preferences, weighted values for selected NavAids by navigation areas were used. If the user selected an aid type as their top choice, it was weighted as 3, second choice was weighted by a factor of 2 and third choice by 1. Data for the Open Ocean waterways are not directly comparable with the other waterway types due to the question format in the survey, resulting in 66 percent fewer responses for this area of operation. However, the results for Open Oceans are otherwise valid and may stand on their own.

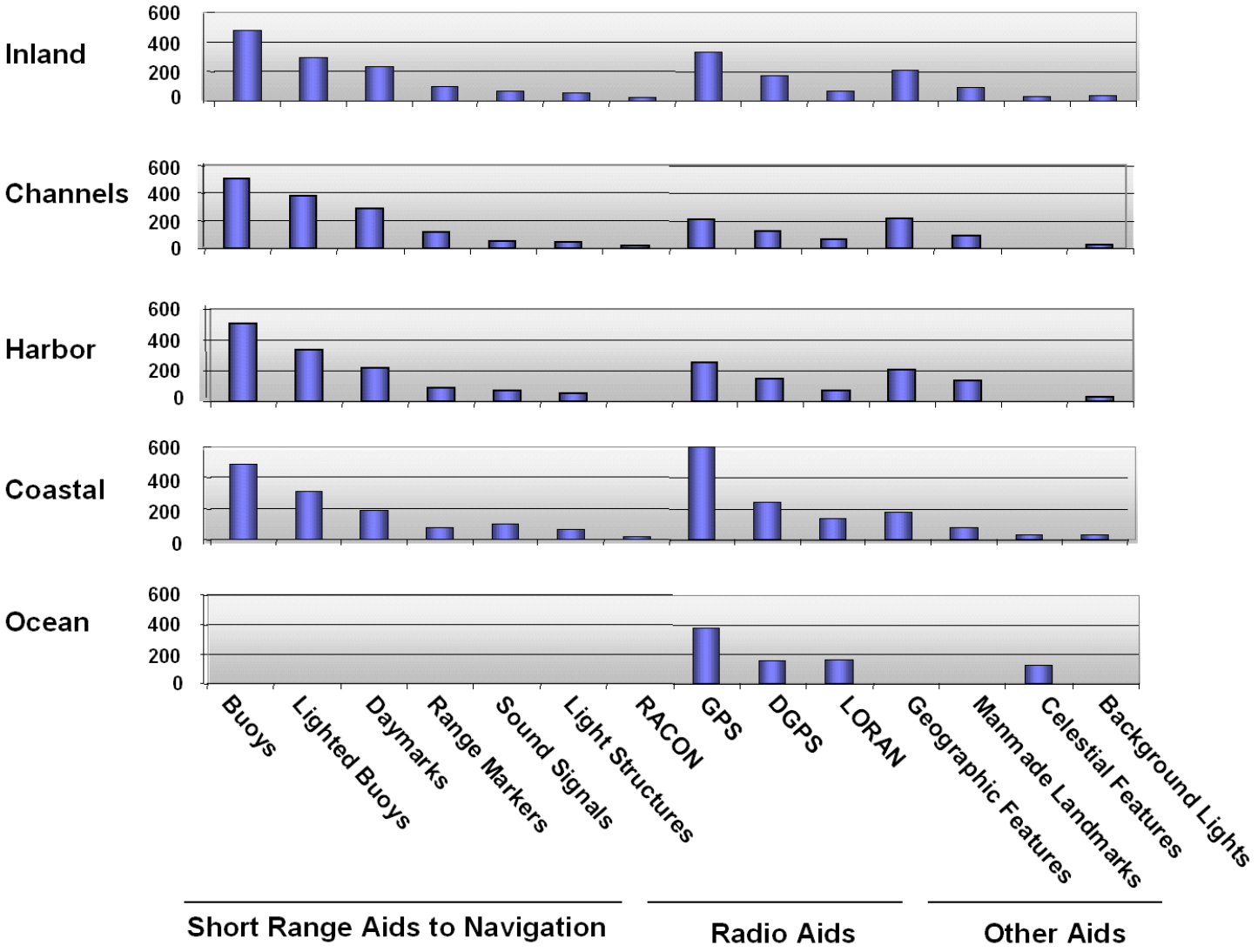
Caution must be used in interpreting Figure 5 for several reasons. The data in this figure are limited to responses from those who operate in all areas. Overall, the data are dominated by recreational boater responses due to the high response level of that group. This, combined with weighting, leads to some distortions in the presentation. For example, ranges appear to be a relatively low preference, but this is because they are designed for vessels constrained to channels by their draft, which are generally the large commercial users. Many of these vessels do not operate in all areas. Another distortion may be the relative strength of the preference for GPS in coastal and offshore waters. In these waters, most recreational boaters have no practical resource other than radionavigation. Larger commercial vessels have powerful radars with high antennas. They may show some preference for radar in coastal waters because it permits them to manage two tasks at once – navigation and collision avoidance. The data in Table 8 of Appendix A show a more detailed picture of relative preferences.

Keeping in mind these cautions, some useful generalizations do appear as a result of the weighted presentation:

- User preferences for NavAids were fairly uniform across narrow channels, harbors and inland areas. Buoys, lighted buoys, GPS, daymarks, and geographic features are the most preferred NavAids in these areas.
- User preferences for NavAids in the near coastal area included those for the channels, harbors, and inland areas, as well as an increase in preference for radio aids (GPS, DGPS, and LORAN.)
- Preferences for aid types in the open ocean are distinct from the other areas. Users rely on radio aids and celestial features in the open ocean.
- Buoys and lighted buoys were highly preferred in all areas where they were available.
- In the near coastal area, users prefer GPS, buoys, lighted buoys, and DGPS.

Figure 5. Weighted Navigational Aid Preference by Area – (Respondents Who Operation In All Areas)

Note: "Weighted" is defined as the sum of the weighted counts divided by the total number of responses.



- In Open Oceans, the users prefer radio aids (GPS, DGPS, and LORAN) and celestial features. Note: while GPS is the only system from this list that is available in all locations, DGPS may be useable 100 or more miles offshore, and LORAN may be available up to several hundred miles offshore. Tampa Bay mariners may benefit from nearly complete coverage of the Gulf of Mexico by both DGPS and LORAN.
- As users progress from the open ocean to port, there is a general trend towards the following preferences for aids to navigation:
  Open ocean - radio aids predominate
  near coastal - mixed preference for radio aids and short range aids
- Harbor, channels and inland – short range aids predominate

This is an interesting finding, as it means that mariners are using progressively "less accurate" means for determining their position for increasingly demanding navigation. That is to say that radio aids are generally the most accurate for determining ***absolute position***, yet mariners prefer them in the open ocean and near coastal areas where this precision is less critical. (Of course to be effective for *navigation*, radio aids must be used in conjunction with a nautical chart.) As navigation becomes more challenging in narrow channels, Harbors and Inland areas, mariners prefer visual aids. Despite the decreased absolute position information derived from these aids, mariners still prefer to use the relative positioning offered by traditional aid systems for the most critical situations. This is not to neglect the precision of the placement of the visual aids, but simply to recognize the inherent difference in the nature of information they provide the mariner (relative vs absolute position information). Familiarity with visual aids, along with the perceived reliability of the low technology involved with these aids, may be part of the reason for this preference. Another reason may be that operating in channels, harbors, and inland areas provides the mariner with two significant tasks – collision avoidance and navigation. Visual aids provide the mariner with information about where to go and where NOT to go while simultaneously permitting the mariner to visually look out for other vessels. Electronic aids, and the current methods for displaying this information, tend to demand separate attention for these two tasks.

Yet another key element may be the lagging development of official electronic charts. The complete suite of NOAA raster charts has only recently become available, and completion of official vector charts for use with ECDIS is still some time away. These systems are critical to taking full advantage of the precise real-time positioning available from GPS/DGPS. Once these charts are available and the electronic chart systems are properly integrated with appropriate sensors and information sources, preference for radio aids in critical navigation situations is likely to increase.

Tables 8A-D in Appendix A provide details on the top choices of aid preference for each user group. In particular, Tables 8B through 8D show that there are important differences among mariners when the results are tabulated by major vessel groups. For example, while a significant percentage of small fishing/charter operators frequently consider LORAN as the most preferred source of information in near coastal environments (13 or 14 of 68 total respondents in each of the three visibility condition columns), none of the 56 mariners in the other four commercial/public vessel categories considered LORAN the most preferred source of information in these areas. It may appear curious that some users identified a preference for sound signals, while there are none in the immediate Tampa Bay area. The logical explanation

is that respondents answered the survey from their entire range of experience, and thus showed some preference for these aids.

How do aid preferences vary with visibility?

The data presented in Figure 8 represent users who indicated that they operate in all areas. Normalized weighted preferences for selected NavAids by visibility were used. The weighting scheme was the same as in the preceding section. Because more mariners operate during the day than at night or under restricted visibility conditions, the summary results weight the NavAids preferences of mariners in less challenging conditions more heavily than NavAids preferences in restricted visibility conditions.

- In general, the top three aids in weighted preference for each of the three visibility conditions are as follows:
  1. day: buoys, daymarks/beacons, and geographic features
  2. night: lighted buoys, buoys, and GPS
  3. Restricted visibility: GPS, lighted buoys, and buoys

- As visibility goes from day to night to restricted, sound signals and radio aids are preferred by an increasing percentage of users.

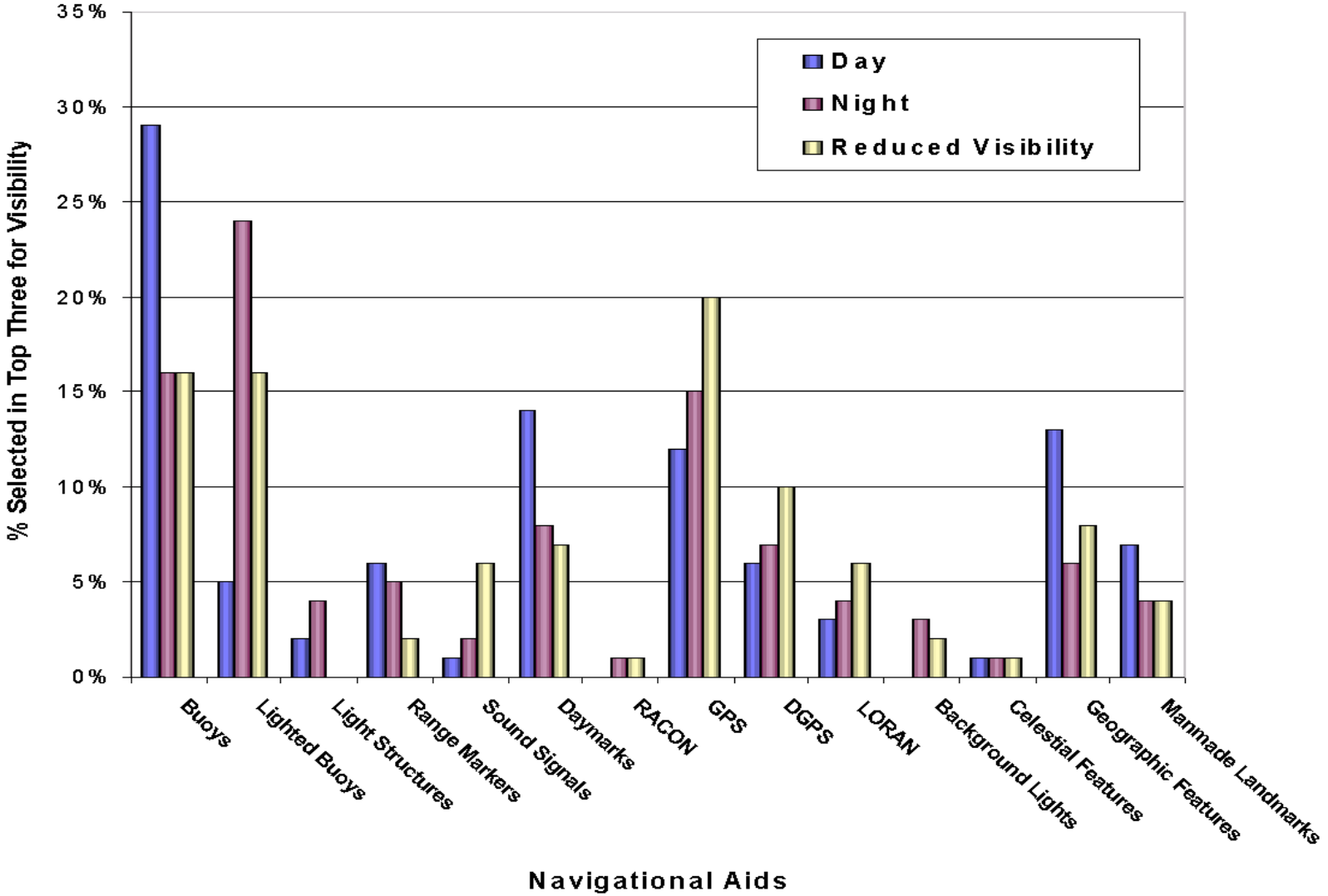
- As visibility goes from day to night to restricted, range markers and daymarks are preferred by a decreasing percentage of users:

Tables 8A through 8D in Appendix A provide a more detailed picture of the extent to which NavAids preferences vary among operators of different vessel groups across different waterway and visibility conditions. For example:

- The percentage of large commercial inter-port operators/pilots who preferred buoys increased from 21 percent during the day to 52 percent under restricted visibility. This apparent contradiction probably means that these operators rely on the radar return more than the visual properties of the aids in restricted visibility. At the same time, their preference for range marks dropped from 46 percent during the day to 9 percent under restricted visibility. Preference for radio aids showed a more modest increase from 17 percent to 26 percent under these conditions.
- While nearly half of recreational boaters cited buoys as the top choice for navigation in harbors by day, the results for both the commercial and public vessel groups and the small fishing/charter group were more evenly distributed. Similarly, over half or the recreational boaters selected GPS as the top choice for navigation in the near coastal area under restricted visibility, and the results for both the commercial and public vessel groups and the small fishing/charter group were again more evenly distributed. Recreational boaters' top choice for all combinations of visibility and areas was limited to Buoys, Lighted Buoys or GPS. All other groups indicated a wider range of top choice as a function of area and condition.
- Geographic features were selected as the top choice for Commercial/Public Vessels in the near coastal area during the day and by Small fishing/Charter vessels in Inland areas during the day and under restricted visibility conditions. These were the only situations where the top choice was from the "Other" category of NavAids.

- Commercial/Public vessels selected Range Marks as their top choice in Harbors at night and narrow channels during the day and night. No other groups selected Range marks as their top choice for any situation. This is consistent with the designed purpose of range marks.

Figure 6. Navigational Aid Preference by Visibility Condition



How does aid use and preference vary with user group?

Understanding the differences in NavAid use among the user groups was the central purpose of this research. Figure 7 shows the data for NavAid Use by User Group. The survey asked respondents to identify all NavAids that are important to them while navigating. The following findings relate to these data.

- All user groups indicated some use of all available navigation information sources. While use of some NavAids (e.g., buoys and/or lighted buoys) is nearly universal among participating mariners, there are pronounced differences across mariner groups for some of the less widely used aids. For example:
  - Group 1 (Large Commercial Vessels and Pilots) and Group 2 (Other Commercial Vessels) indicated no use of celestial features
  - Group 3 (Commercial Port-based Fishing Vessels) indicated no use of sound signals
  - Group 4 (Military and Public Vessels) indicated no use of LORAN

- The pilot study results indicate that the degree of use of different types of aids varies across user groups. The most striking variations are in the use of radio aids.
  - While 61 percent of the small fishing/charter operators (Group 5) reported that they use LORAN, no more than 30 percent of any other group reports use of this aid.
  - While 64 percent of the large commercial inter-port vessel operators and pilots in Group 1 report use of DGPS, only one-third of the other commercial port-based group and small fishing/charter group mariners use DGPS. Public /Military vessels (Group 4) reported a DGPS usage rate of 50 percent, while recreational users reported the lowest usage at only 14 percent. Low use of DGPS by recreational boaters is not surprising. Navigation of small craft for recreation is generally less demanding since operations are often discretionary (mariners avoid situations where navigation might be critical) and recreation vessels generally operate with less constraints due to draft. Many operators may have decided that the improved accuracy is not worth the additional investment for differential equipment. The decision in May 2000 to set Selective Availability to zero has also allowed an instant improvement of an order of magnitude in the accuracy of the civil GPS signal, which may prove sufficient for many recreational users. It seems reasonable that operators engaged in more challenging navigation situations will continue to use DGPS or the Wide Area Augmentation System (WAAS) for improved position accuracy. While WAAS was designed to support aviation navigation, it is rapidly being introduced into marine GPS receivers as well. DGPS users get the additional benefit of integrity monitoring and warning when the system is operating out of tolerance.
- The use of light structures, daymarks and sound signals was quite varied among user groups, but no particular trend was evident.
- The use of lighted buoys and celestial features varied the least among users, i.e. the use of lighted buoys was consistently high, and the use of celestial features was consistently low.

See Table 5 in Appendix A for detailed responses by each user group.

In a separate question, respondents were asked to indicate up to three navigation information sources (aid types) that they *preferred*, in order of preference. These results were tabulated as "aid preferences." The data were weighted by priority as before, where the user's top choice was weighted by 3, -second choice by 2 and third choice by 1. The weighted aid preference data were also normalized by the number of responses for each vessel type, and are presented in

Figure 6. Additional details on NavAid preferences may be found in Tables 7A and7B in Appendix A.

- The preference for range markers varies the most among the user groups.
  - Group 1 (Large Commercial Inter-port Vessel users) is distinguished by a strong preference (46 percent) for range markers as the most preferred source of information.
  - Some users within Group 2 (Other Commercial Port-based Vessel users) also showed a preference for range markers (ship assist tugs – 36 percent, and (1) dredge – 33 percent). Limited use by other members of Group 2 resulted in a group usage rate of only 14 percent.
  - Less than 10 percent of the respondents from Groups 3-5 cited range marks as the most preferred source of information. This is reasonable since most of these vessels are not constrained to the deep draft channel.
- The preference for radio aids varies moderately among the user groups. Since DGPS is an augmentation of GPS, the perceived distinctness of the two systems varies. Several user groups tended to prefer one or the other, but not both. The exceptions to this are with the Public/Military users (Group 4) and the Small Fish/Charter users (Group 5). These groups show a relatively high preference for both GPS and DGPS. Military users benefit from the Additional P code GPS signal, which provides them with greater accuracy than standard GPS service, and may be part of the reason they show a preference for both GPS and DGPS.
- Small Fishing and Charter respondents (Group 5) are also distinguished by their strong preference for Loran.
- While only 16 percent of large commercial inter-port operators/pilots and 20 percent of other commercial port-based operators cited GPS or DGPS as their most preferred source of information, at least one-third of the respondents in each of the four other vessel groups did so.
- Table 7A shows the Small Fishing/Charter group is only group to prefer radio aids (cumulative) in all conditions. Table 8C indicates this preference is primarily in near coastal area, and LORAN is the top choice among the radio aids. Figure 7 shows this group uses LORAN more that twice as much as any other group.
- The preference for the following aid types varies the least among the user groups, and is consistently modest to low:

background lights	celestial features
RACONs	man-made landmarks

- In general, the most preferred aids are:

buoys	DGPS
GPS	geographic features
lighted buoys	

- In general, the least preferred aids are:

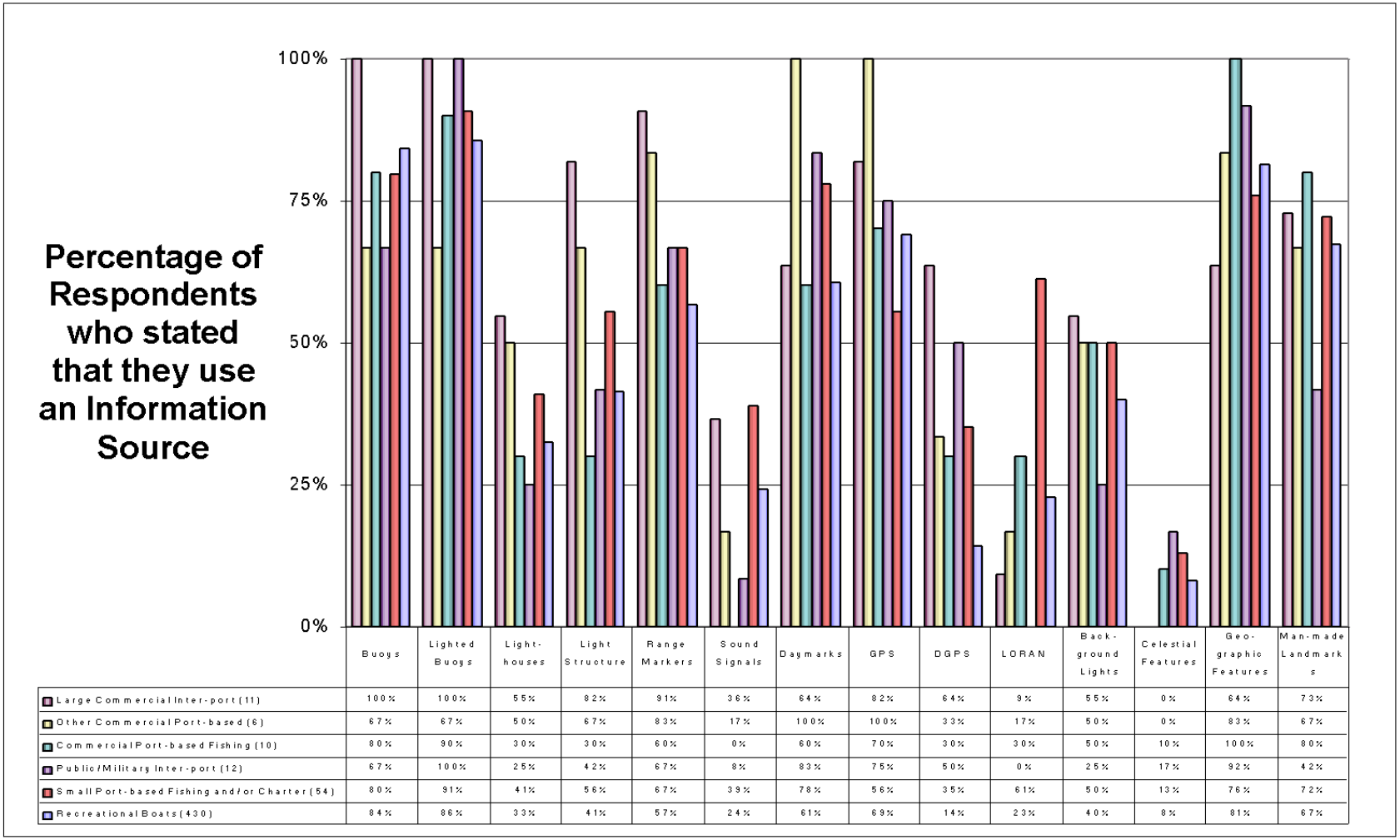
RACONs	celestial features
background lights	light structures

The preceding data on aid use indicate that mariners use any and all NavAids available to them. However, the data on preferences suggest that the mariners have definite preferences for specific aid types. For example, Large Commercial Inter-port Vessels operators (Group 1) use buoys, lighted buoys, light structures, range markers, daymarks, GPS, man-made landmarks, and geographic features. However, they show a very strong preference for range markers over all others. Furthermore, while light structures, sound signals, background lights, and man-made landmarks, are used, they are not highly preferred.

As mentioned above, the Small Fishing and Charter respondents (Group 5) show a strong preference for LORAN. Operators in this group often develop a database of favorite locations, and rely on the repeatability of LORAN to consistently relocate those locations with ease. In this case, these positions are defined by the LORAN Time Differences (TDs). Previously, GPS could not match this repeatability due to the position inaccuracies introduced by Selective Availability (SA). With SA turned off, GPS is now more repeatable and more accurate than LORAN, and can satisfy this need. Since operation of the LORAN has been extended past 2000 for an unspecified period while the long-term need for the system is evaluated, there may be insufficient motivation to convert to GPS at this time. However, it should be noted that this survey was conducted only 6 months after SA was turned off, so this preference may change as operators gain confidence in the improved performance of GPS, combined with low availability of new LORAN receivers.

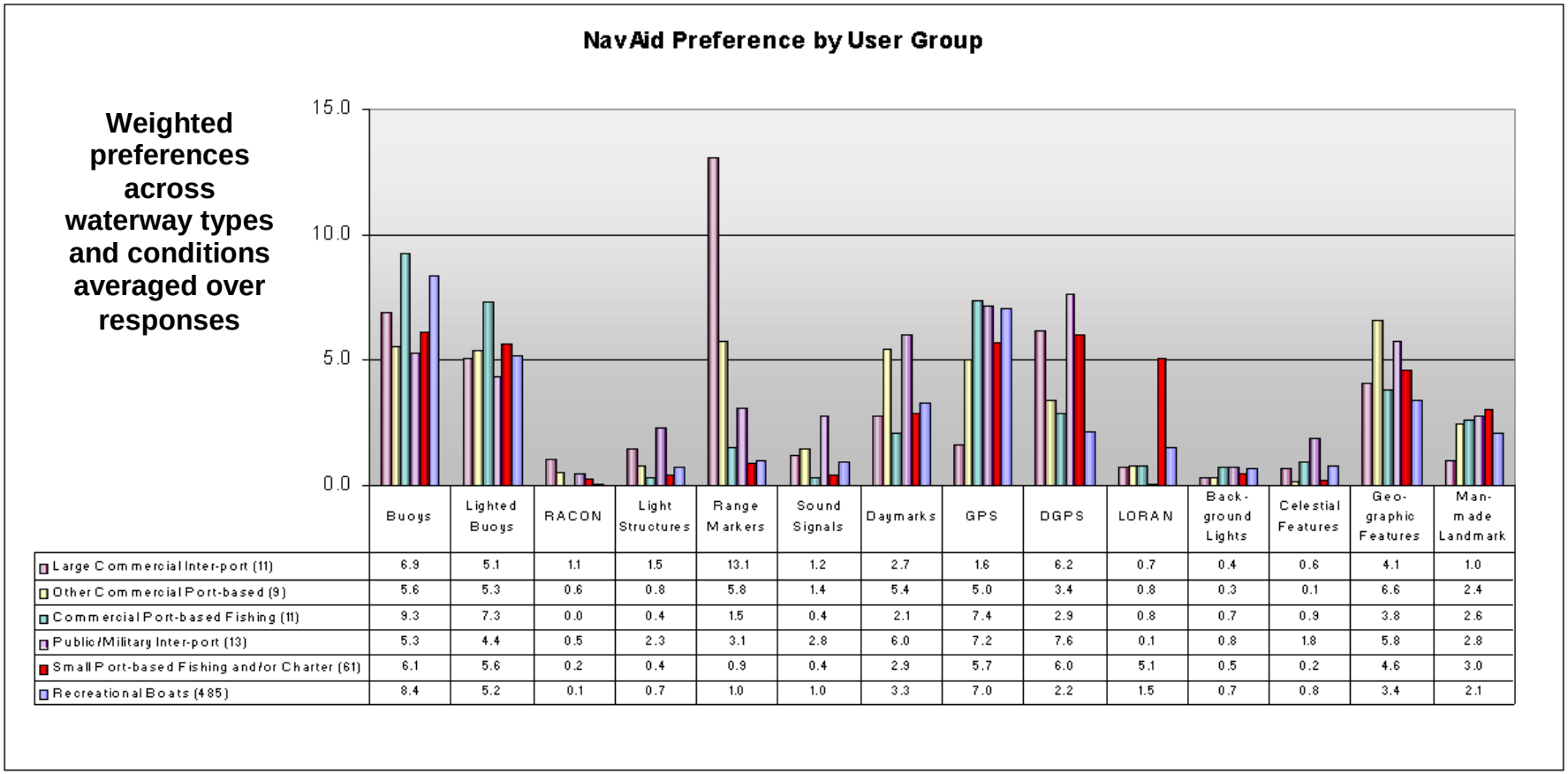
Finally, Table 9 in Appendix A (“Primary NavAid Preferences by User Group”) summarizes the distribution of reported preferences by user group across the three major categories of NavAids: short range, radio, and non-USCG aids. While more than ten percent of the respondents in the small fishing/charter and the recreational groups selected radio or non-USCG sources of information for at least 50 percent of the waterway/visibility condition combinations in which they operate, none of the mariners in any of the other four vessel groups did so.

Figure 7. Navigational Aid Usage by User Group



	Buoys	Lighted Buoys	Light-houses	Light Structure	Range Markers	Sound Signals	Daymarks	GPS	DGPS	LORAN	Back-ground Lights	Celestial Features	Geo-graphic Features	Man-made Landmarks
Large Commercial Inter-port (11)	100%	100%	55%	82%	91%	36%	64%	82%	64%	9%	55%	0%	64%	73%
Other Commercial Port-based (6)	67%	67%	50%	67%	83%	17%	100%	100%	33%	17%	50%	0%	83%	67%
Commercial Port-based Fishing (10)	80%	90%	30%	30%	60%	0%	60%	70%	30%	30%	50%	10%	100%	80%
Public/Military Inter-port (12)	67%	100%	25%	42%	67%	8%	83%	75%	50%	0%	25%	17%	92%	42%
Small Port-based Fishing and/or Charter (54)	80%	91%	41%	56%	67%	39%	78%	56%	35%	61%	50%	13%	76%	72%
Recreational Boats (430)	84%	86%	33%	41%	57%	24%	61%	69%	14%	23%	40%	8%	81%	67%

Figure 8. Navigational Aid Preference by User Group



	Buoys	Lighted Buoys	RACON	Light Structures	Range Markers	Sound Signals	Daymarks	GPS	DGPS	LORAN	Back-ground Lights	Celestial Features	Geo-graphic Features	Man-made Landmark
Large Commercial Inter-port (11)	6.9	5.1	1.1	1.5	13.1	1.2	2.7	1.6	6.2	0.7	0.4	0.6	4.1	1.0
Other Commercial Port-based (9)	5.6	5.3	0.6	0.8	5.8	1.4	5.4	5.0	3.4	0.8	0.3	0.1	6.6	2.4
Commercial Port-based Fishing (11)	9.3	7.3	0.0	0.4	1.5	0.4	2.1	7.4	2.9	0.8	0.7	0.9	3.8	2.6
Public/Military Inter-port (13)	5.3	4.4	0.5	2.3	3.1	2.8	6.0	7.2	7.6	0.1	0.8	1.8	5.8	2.8
Small Port-based Fishing and/or Charter (61)	6.1	5.6	0.2	0.4	0.9	0.4	2.9	5.7	6.0	5.1	0.5	0.2	4.6	3.0
Recreational Boats (485)	8.4	5.2	0.1	0.7	1.0	1.0	3.3	7.0	2.2	1.5	0.7	0.8	3.4	2.1

IV. Alignment of Program Services with Survey Findings.

The pilot survey of the Tampa Bay area revealed no clear areas of outdated or substantially misaligned services. This does not mean that services are properly aligned in all regional contexts. Mariner preferences and behaviors show the mixed use of short range and radio aids to navigation. This generally agrees with how these systems are designed and operated. The evolution of marine navigation for high-end users will certainly include the future integration of advanced electronic systems, such as GPS, DGPS, ECDIS, electronic charts as well as integrated radar, positioning, chart information, and automatic identification system (AIS) data. Current patterns in user preferences suggest that short range (visual) aids will continue to be part of the aid mix preferred by users for the foreseeable future. There are some patterns of use that suggest areas for adjustment in the mix of aids to navigation, although closer study will be needed.

The survey findings should be viewed with due regard for the level of statistical significance associated with this pilot survey of Tampa Bay. The results reflect just one geographic area, and the levels of response varied greatly among the user groups. Reasonably good results were compiled for recreational boaters and small port-based fishing and charter vessels. The higher than average response rate of Tampa Bay pilots gives particular weight to the stated preferences of large commercial inter-port vessels. Response levels for other commercial port-based vessels, commercial port-based fishing vessels, and public vessels were too low to be confident of their significance.

The responses did reveal patterns that are useful to consider in assessing program alignment. The following patterns are noteworthy, and comments on program alignment are offered:

1. Self declared needs for position accuracy and frequency show a clear desire for more frequent and more accurate positioning as mariners move from open ocean to coastal waters and into channels and harbors. Self declared preferences for aids to navigation show a general preference for radionavigation services in open ocean and coastal waters, transitioning to a distinct preference for visual aids to navigation in channels and harbors. There is paradox in these results. Radionavigation services offer the potential for extremely precise, continuous positioning information, yet visual aids are preferred where precise, continuous information is most desired. There are several possible explanations for this.

- In constrained waters, mariners prefer a relative orientation to nearby dangers rather than an absolute plotted position. In other words, navigation in these situations is more like driving a car. Visual references provide more valuable continuous information and more agreeable spatial orientation in this context.
- In channels and harbors mariners must manage both navigation and collision avoidance. Visual aids to navigation integrate these two tasks; current electronic navigation systems (non-radar) tend to separate these two tasks.
- Most visual aids to navigation also provide a radar return, and thus are integrated into the mariner's navigation and collision avoidance tasks on radar-equipped vessels. This dual functionality makes short range aids particularly useful in confined waters, and at night or in restricted visibility.

- Electronic navigation could better integrate collision avoidance information and provide a relative orientation to the mariner, but this potential is largely unrealized today. Only about a quarter of GPS/DGPS users in this survey had electronic charts, which provide the basic level of interface between positioning data and an image of the waterway and its relative dangers. Further integration with radar and other vessel information is becoming possible for larger commercial vessels through radar, Automatic Radar Plotting Aid (ARPA) and AIS interface with electronic chart systems. While this is possible for smaller commercial and recreational vessels as well, mandatory carriage and practical use may be feasible for only a minor segment of these groups. In addition to improved integration of systems for electronic navigation, there remains a host of issues surrounding implementation of this technology. Such things as carriage requirements, system availability, reliability and redundancy, human factors design and training must be addressed to ensure that the new technology is implemented in such a way as to positively improve navigation safety and mobility. As of today, short range aids provide the simplest, easiest to use, and most universally available aids to navigation that readily integrate mariner positioning, relative positioning, hazard and collision avoidance tasks.

These results, along with the possible explanations, suggest the following about program alignment.

- *Aids to navigation services are generally aligned with user needs and expectations.* The majority of short range aids to navigation are positioned in waters where they are most preferred. It is difficult to separate how much of this user preference is created by the very presence of these aids in channels, harbors, and inland waters, but the independent determination that mariners need the highest level of service in these areas supports this distribution of resources. Given the consistent user preference for visual aids to navigation, and particularly buoys, further investment in technologies to reduce the lifecycle costs of these aids is warranted. User preference for visual aids in channels, harbors, and inland waters does not mean that the current design of these aid systems is necessarily optimal. Further research in channel design standards, risk assessment and analysis of mariner performance may lead to improved designs and/or lower cost configurations.
- *The mix of aids to navigation services in coastal waters warrants further examination.* The level of GPS carriage in this survey is noteworthy, not only because GPS provides significantly better positioning information than LORAN-C for coastal navigation, but because the powerful functionality, low cost, and ease of installation of GPS equipment promise to make it a shaping force in navigational practice. While this survey alone is inconclusive, shifts in mariner preference to radio aids to navigation in coastal and ocean waters suggest that Waterways Analysis and Management System (WAMS) evaluations regularly examine the usefulness of short range aids aimed principally at serving coastal waters. These aids include major landfall lights and lighthouses, light towers, and large coastal buoys. There are still those who cite a preference for visual aids in coastal waters and who are likely to resist wholesale changes until GPS use becomes more widespread and accepted. However, continued evaluation of mariners' use of these aids should be a part of the planning for future system work in coastal waters.

- *A more complete integration of electronic navigation systems with mariners' tasks will prove key to advancing navigational performance and shaping the use of aids to navigation.* To achieve the desired outcomes of GPS and DGPS service, the Coast Guard may need to take a more active role in stimulating the development of systems that integrate position information into the functional world of the mariner. Research in this area would increase the Coast Guard's understanding of risk modeling and total system performance, potentially stimulate commercial advances in systems development, and eventually support any regulations needed to enable the full potential of electronic navigation systems.

2. While the use of different aids varied across user groups, the most striking variations were in the carriage and use of radio aids. Although the significance of some findings is uncertain, the patterns observed are interesting and suggest further research. Almost 75 percent of the respondents overall said they carried a GPS. 77 percent of recreational boats reported they carried GPS – a significant finding based on the sample size. 64 percent of the large commercial inter-port vessel operators and pilots reported the use of DGPS, a number probably driven by the Tampa Bay pilot's use of DGPS. This contrasts with only 14 percent of recreational boaters claiming to use DGPS. Despite high carriage rates for GPS or DGPS equipment on large commercial inter-port operators/pilots and commercial port-based operators, only 16percent and 20percent (respectively) of these groups cited GPS or DGPS as their most preferred source of information. On the other hand, the small fishing and charter group preferred radio aids (cumulative) in all conditions, with LORAN-C the top choice in coastal waters.

These patterns suggest the following about program alignment:

- *LORAN-C use by fishing vessels was unusually high.* The size of the respondents in this group makes this finding noteworthy. A commonly accepted explanation is the preference of fisherman for the repeatability of LORAN-C and the difficulties in converting their Time Differences (TDs) to accurate latitude and longitude coordinates for fishing locations. The removal of Selective Availability from GPS occurred just a few months before this survey was conducted and may not have fully impacted the behavior of the users. The continued development of GPS and related services, and the cost of replacing marine LORAN-C receivers suggest that market forces will combine to steadily reduce the maritime use of LORAN-C by fishing vessels. The Coast Guard recognizes the slowly declining maritime use of LORAN-C and the shift of its relative importance to aviation. However, this survey's self reported LORAN-C use and revealed preferences for LORAN-C among fisherman suggest continued monitoring.
- *Radionavigation use appears to be changing dramatically*. Estimates of radionavigation use in this survey are higher than in previous studies, such as the 1998 Recreational Boating Safety Survey. This is due largely to the sample frame of coastal ocean users found in the Tampa Bay area. This cross section of users more closely matches the users who rely on Coast Guard services, however, so this information is particularly valuable. The rapid growth of GPS promises to shape future trends in marine navigation. For the purposes of program management it would be valuable to capture such user information on a more frequent basis throughout the country. For recreational boaters, it may be possible to create a small survey instrument for inclusion in the larger annual

Recreational Boating Safety Survey. Capturing information on commercial and public users on a recurring basis would be equally valuable, and may be possible in conjunction with other Coast Guard survey's or studies.

3. Despite their carriage of advanced electronic navigation equipment, large commercial inter-port vessels and pilots show a marked preference for visual aids to navigation. Buoys, lighted buoys and ranges dominate their selection of preferred information sources. When weighted according to relative preference, ranges become the dominant aid, but DGPS becomes extremely important as well. This is rational considering that these mariners must navigate vessels constrained to narrow channels. Their immediate information needs are the channel centerline marking deep water and the lateral limits of safe water. The dominance of DGPS may reflect the special operations of the Tampa Bay Pilots, who carry portable DGPS units to do their work.

An interesting pattern of behavior appears in these large commercial inter-port vessels and pilots when they move from clear visibility to restricted visibility (fog, rain, snow, etc.) Ranges are no longer valued once they are obscured, but mariner preference shifts disproportionately to buoys as opposed to radio aids to navigation. This seems illogical, since buoys would normally not be visible in fog. The most logical explanation is that the pilot tasks of navigation and collision avoidance are greatly complicated in restricted visibility, and the radar return from buoys permits the integration of these two tasks. Therefore, they are valued more than absolute position provided by radio aids.

These general patterns of behavior suggest the following:

- *Buoys and ranges will remain important to large commercial vessel navigation, which often involves the highest risk.* Accordingly the Coast Guard should anticipate ongoing demand for these aids and continue research into improved technologies that will increase their effectiveness and operational efficiency.
- *Recommendation 30 of the 1994 National Research Council study "Minding the Helm" remains valid.* The behavior patterns observed in this survey generally match or are explained by this study. Recommendation 30 reads:

  "The U.S. Coast Guard should maintain, and when appropriate, enhance existing short range aids to navigation that will support evolving technologies as well as traditional navigation technologies. In particular, the U.S. Coast Guard should continue efforts to improve visibility and electronic acquisition of buoys during adverse sea and weather conditions. The U.S. Coast Guard should examine the feasibility of electronic ranges and distance-measuring equipment for specialized local use, which could be in the form of a local Differential Global Positioning System."

Recommendations for Future Work

Survey

The AtoN User Survey instrument developed by RDC, combined with the survey campaign methodologies and vessel grouping strategies, provide a prototype tool for understanding

mariners' needs for navigational aids. The Tampa Bay area pilot survey provided an opportunity to field-test this integrated, multi-mode approach to information collection and assessment.

The pilot survey process yielded information that can be used to refine the methodology and to enhance the prospects for obtaining statistically reliable results in the future. For example, the analysis would have benefited from an assessment of the relative levels of harbor and other waterway use (exposure) by vessels included in each proposed category. In some cases, there may be very wide variations in use among vessels within a group. Because the extent to which this variation exists is important in determining proper group classification (as well as optimal sample size allocation) any follow-on survey efforts should incorporate some collection of waterway exposure data from participants. This will not only generate information to corroborate the vessel groups used for analysis, but it will also provide some estimates of the relative importance of these groups in terms of the overall level of use of the various AtoN and other NavAids in the area studied.

The pilot study database includes an adequate number of responses, at least on a preliminary basis, for two or three categories of mariners. However, operators and pilots of large, ocean-going vessels are under-represented, relative to their share of overall port traffic (4500 port calls in 1999). A supplemental survey effort in the Tampa Bay area for augmenting the sample size of selected groups of important, but hard-to-reach mariners would increase the validity of the findings associated with this study.

The results obtained in any single port may not be representative of NavAid use nationally. Factors will vary from area to area. Experience suggests that there are five somewhat distinct areas in the country that would require sampling to gather enough information to assemble a national picture of NavAid use. These areas are the Pacific, Gulf and Atlantic coastal regions as well as the Great Lakes and Western Rivers. With appropriate modifications to the survey instrument and administration, and a comprehensive data collection effort, this approach should yield usable results for each of the six vessel groups that were used for the analysis presented in this report.

Evaluation

The data collected through the Tampa Bay user survey provides some insight into the NavAid preferences of mariners operating in the area. While there are recognized shortcomings regarding statistical adequacy of the samples and the clarity of certain questions in the survey, the findings are informative and illustrate the nature of information that might be extracted from a fully implemented survey of this type.

When considering all user groups in the Tampa Bay data sample, narrow channels, harbors, and near coastal areas are used the most, inland areas are used the least and open ocean use is intermediate. The various user groups responded differently to the challenges posed by night and reduced visibility, but in general, operations under these conditions were reduced compared to daytime levels. Recreational boaters showed the most significant reduction in operations due to conditions.

The data suggest that mariners generally carry a basic suite of navigational equipment including a compass, radio, charts, binoculars, GPS, Fathometer, and speed indicator. The vast majority of mariners who carry this equipment use it. Very few mariners saw the need to carry traditional equipment such as a sextant or alidade.

As users progress from the open ocean to inland, there was a general shift in preference from radio aids to short range aids. At the same time users indicated a strong preference for buoys and lighted buoys in all areas where they were available. User preferences for aid types were fairly uniform across narrow channels, harbors and inland areas.

As visibility goes from day to night to restricted, radio aids and sound signals are preferred by an increasing percentage of users, and range marks and daymarks are preferred by a decreasing percentage of users. The preference for lighted buoys increases from day to night. However in reduced visibility the preference for lighted buoys is the same as the preference for buoys, indicating that it is the radar return, not the light that is being used.

All user groups indicated some use of all available navigation information sources, with only a few exceptions. The small fishing/charter operators were unique in their relatively high use of LORAN. The use of lighted buoys was consistently high, and the use of celestial features was consistently low across all user groups. When asked about aid preferences, users indicated the most preferred NavAids were buoys, GPS, lighted buoys, DGPS and geographic features. The least preferred NavAids were RACONs, background lights, celestial features and light structures.

The survey also revealed a consistent trend in the desired frequency and accuracy of vessel position information. Users say they require position information more frequently and with greater accuracy as the area of vessel operation becomes more constrained.

REFERENCES

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U.S. COAST GUARD
Research & Development Center

APPENDIX A

EXTRACTS FROM

THE REPORT OF RESULTS

PILOT SURVEY OF AIDS TO NAVIGATION (AtoN) USERS CONDUCTED IN THE TAMPA BAY, FLORIDA AREA, SUMMER 2000

MAY 2001

For The
USCG R&D Center, Groton, Connecticut

Prepared By XL Associates, Inc. and Heiden Associates, Inc.

USCG AtoN User Pilot Survey – Report of Results

Table of Contents

LIST OF TABLES AND ATTACHMENTS

INTRODUCTION AND BACKGROUND

The Aid Mix Project

The United States Coast Guard Research and Development Center (RDC) has been engaged in a project to develop the information, methods and tools to assist the Coast Guard in determining the future Aids to Navigation (AtoN) System requirements and related program policies and strategies. This effort was called the Aid Mix Project. As a part of this project, RDC developed a web-based survey instrument to assess the navigational behaviors and preferences of AtoN users. RDC contracted with XL Associates, Inc (assisted by its subcontractor, Heiden Associates, Inc.) to deploy the instrument in the Tampa Bay, Florida area. This report describes the results of the AtoN user survey Tampa Bay campaign, conducted in August and September 2000. CACI International, Inc. also contributed to this effort and produced most of the data tables contained in this report.

The survey was targeted to reach all AtoN users in the Tampa Bay area, composed of several major population segments. These segments included Commercial Vessel Operators, Public/Military Vessel Operators, and Recreational Vessel Operators. Information was collected from participating Tampa Bay mariners on vessel characteristics, operator training/experience, NavAid requirements, availability and use, and NavAid preferences across a variety of waterways and visibility conditions. A total of 698 responses were collected, 641 of which were usable for analysis.

The AtoN User Survey instrument, combined with the survey campaign methodology and vessel-grouping strategies, provides an important tool for achieving the goals of the survey. The Tampa Bay area pilot survey provided an opportunity to field test this integrated, multi-mode approach to information collection and assessment, and provided feedback to ensure that the final version of this survey tool will be an effective resource for assisting the USCG in understanding user needs for Aids to Navigation.

Report Scope

This report describes the results of the AtoN user survey campaign conducted in August and September 2000 in the Tampa Bay area of Florida. The methodology developed and used by XL ASSOCIATES, INC to implement the survey is described separately in their report, "*USCG Aids to Navigation (AtoN) User Survey Methodology Report, Pilot Survey, Tampa Bay, Florida Area, Summer 2000*." [XL Associates, 2001]

FOCUS AND RANGE OF SURVEY QUESTIONS

The survey asks AtoN users to provide the following information:

- The user's demographic and contact information,
- The user's number of years of marine experience,
- The type of vessel most frequently operated,
- The types of navigation equipment available and used on the vessel,
- Whether the user is a licensed Marine Pilot,
- Whether the user holds a professional USCG or Merchant Marine license,
- The visibility conditions that the user operates the vessel in,

- The types of waterways in which the vessel is operated,
- The types of NavAids used, and under which conditions of operation and waterway types,
- The user's preference for the type of NavAid used, and under which conditions of operation and waterway types, and
- The specific ways in which the vessel operator uses selected NavAids.

AtoN USER SURVEY RESULTS

Analysis of the Tampa Bay area survey data requires looking at aggregated results for groups with common vessel characteristics, NavAids availability/use, and operator training. This grouping is needed to generate adequate sample sizes for preliminary analysis of the survey data.

Sample Size Adequacy

Full-scale analysis requires sample sizes that afford an acceptable level of statistical precision. However, the sample size depends on what statistical tests will be run, and the degree of confidence that is required for the results. The variability of responses within the subgroups will also influence either the required sample size or resulting confidence levels. The greater the variability, the greater the sample size needed to discern the real differences between the groups with confidence. Since the specific statistical tests and questions to be answered were not developed in advance for this pilot survey, there was insufficient guidance to determine the necessary sample sizes. However, given the response rates that were achieved for this survey, some preliminary conclusions can be drawn. For example, a sample size of 18 (Public/Military Inter-port vessels) is sufficient to estimate the population mean is within one half standard deviation.

A sufficiently large sample is available from the pilot survey data for Small Port-based Fishing/Charter Vessels (Group 5) and Recreational Boaters (Group 6). The sample for Public/Military Vessels is marginally adequate as mentioned above. Achieving adequate sample sizes for other mariners, even at the pilot/preliminary level of statistical reliability, requires aggregating together vessel types. Further, follow-up data collection is recommended to increase the level of confidence in the preliminary results for important categories of vessels, such as the large commercial vessels in group 1.

Development of Vessel Groups for Use in Analysis

Because there are a lot of vessel types with very few survey responses, it was both reasonable and necessary to develop a limited number of groups for the non-recreational vessels based on common characteristics of vessel structure, use or NavAids requirements. These groups can be used to evaluate NavAids use or preferences, as well as to check the validity of individual survey responses.

Potentially Relevant Criteria

Non-recreational vessels can be divided into a limited number of groups based on any number of ship, cargo, operator or use characteristics. The following is a list of reasonable criteria for performing the classification of user groups:

- Vessel size/maneuverability,
- Use of harbor channel vs. areas closer to shore when coming into or leaving port,
- Likelihood of pilot assistance with harbor/bay navigation,
- Likely familiarity with harbor/bay area (port-based vs. ocean-going vessels),

Description of User Groups

The mapping of vessel types listed in the web survey instrument to groups based on the above listed criteria, as well as the number of pilot study responses in each group, is presented in Table 1, "Vessel Type Categories." A more detailed description of the major groups is presented in the main body of this report.

Overview of Survey Response Data

The AtoN survey collected information from Tampa Bay mariners on vessel characteristics, operator training/experience, NavAids requirements, availability and use, and mariner NavAids preferences across a variety of waterways and visibility conditions.

However, data are available from the Tampa Bay area pilot study for just under 700 survey participants. Most (517 of the 641 with a specified vessel type) are recreational boaters, and more than 50 additional respondents did not report a vessel type. Even using the vessel grouping approach recommended and adopted in this report, sample sizes are less than 20 for 4 of the 6 vessel groups.

With this level and pattern of responses, we can only conduct a preliminary assessment of the results obtained from the Tampa Bay area pilot study. Our analysis presents results for all six groups, but only a limited number of statistically meaningful inferences can be drawn for mariners in each of the first four vessel groups individually. Where appropriate, results are presented on a combined basis for comparison purposes.

Caution should be exercised in interpreting any of these results. Recruiting survey participants required a great deal of effort that may lead to self-selection bias among respondents, and the survey instrument required participants' careful attention to detail to produce a complete set of responses.

Moreover, these results do not, in our [*XL Associates*] view, serve as the basis for a final determination and/or confirmation of the appropriate criteria to use for vessel grouping. They do, on the other hand, suggest that vessel characteristics and NavAids requirements, availability and use do differ significantly across various vessel categories.

Table 1 **Vessel Type Categories** and Survey Response Rate	
Vessel Type	**Number of Survey Responses**
1. Large Commercial Inter-port Vessels	**12**
Pilot (Unspecified Vessel)	8
Container	1
Cruise Ship	1
Tanker (Crude Oil)	1
Tanker (Refined Petroleum)	1
2. Other Commercial Port-based Vessels	**14**
Harbor Cruises/Tours	4
Tug (Ship Assist)	4
Rescue	2
Salvage	2
Dredge	1
Ferry/Water Transit/Commuter	1
3. Commercial Port-based Fishing Vessels	**12**
Fishing (Trap)	5
Fishing (Trawl)	4
Fishing (Gillnet)	3
4. Public/Military Inter-port Vessels	**18**
State	6
USCG	6
Research	4
Marine Corps	1
Navy (Surface)	1
5. Small Port-based Fishing/Charter Vessels	**68**
Charter	26
Fishing (Hook & Line)	25
Fishing (Charter)	17
6. Recreational Vessels	**517**
Motor	296
Sail	210
Human Power	8
Recreational (Unspecified)	3
Total Responses	**641**

Summary Data to Evaluate Validity of Vessel Groups

Data are available from the survey on several vessel characteristics, including beam width, draft, and length, as well as average and maximum transit speeds. Respondents were also asked whether they held a USCG license, and their years of experience as mariners. Finally, respondents were asked about the nature of the waterways in which they operate and the range of visibility conditions they encounter when using each of these waterway types. These data can be reviewed to determine if the proposed vessel groups are appropriate.

Table 2 ("Vessel Characteristics by User Group") indicates that the vessels included in the large inter-port category (Group 1) are substantially larger than most other vessel types. It also highlights the diversity of the vessels combined in the other inter-port and other port-based groups.

Table 3 ("Respondent Characteristics by User Group") confirms that operator training is one of the criteria that can be used to evaluate the classification of vessel types into the proposed groups. Virtually all of the Group 1 respondents and most of the other commercial port-based group respondents reported having USCG licenses. Twenty five percent of the commercial fishing (Port-based Fishing Vessels) and 11 percent of the Public/Military inter-port vessel mariners also hold licenses. It should be noted that operator license-holding in the small fishing/charter group is not entirely consistent. While very few hook & line vessel operators have licenses (as is the case for the gillnet, trap, and trawler fishing boat operators), at least half of the charter and fishing charter boat operators reported having a USCG license.[2] Finally, Table 4 ("Responses for Waterway and Condition by User Group") indicates that the frequency of inland and ocean exposure varies across vessel groups. Most of the vessels in the other port-based group were operated in inland waterways, while only 4 of the 14 respondents reported navigating on the open ocean. In contrast, half or less of the mariners in the other four non-recreational groups reported navigating on inland waterways, while 50 percent or more of each of these four groups indicated that their vessels were used in open ocean areas.

Implications for Further Survey Work and Analysis

The Tampa Bay area pilot study provided valuable information that can be used both to refine the survey methodology and to enhance the prospects for obtaining statistically reliable results. The recommended vessel grouping approach is an important element of this refinement process. Advance determination of the statistical tests to be run and the hypotheses to be tested is also critical to determining adequate sample size.

Use of Vessel Groups to Guide Follow-On Data Collection Efforts

While specific vessel type information should be requested from follow-on study participants (as in the Tampa Bay area pilot survey), the vessel groupings serve two functions in the data collection process:

[2] This ambiguity about the proper classification of hook & line fishing vessels underscores the value of collecting vessel usage (exposure) estimates as part of the survey data, since the vessels used in the commercial and rental/tourist segments of the fishing/charter sector appear to be characterized by similar dimensions and speeds.

- To assess the adequacy of the number of survey responses collected from various categories of mariners, which can be used to guide the targeting of additional survey participant recruitment activities; and
- To provide a benchmark against which to verify the validity of individual survey responses.

Using this grouping approach, however the specifics are modified on the basis of additional experience, will also provide a framework for testing the consistency of responses across multiple data collection sites.

Enhancement of the Grouping Criteria by Collection of Exposure Data

While a preliminary set of vessel groups is presented in this report, we have not developed an assessment of the relative levels of harbor and other waterway use (exposure) by vessels included in each proposed category. In some cases, there may be very wide variations in use among vessels within a group. Because the extent to which this variation exists is important in determining proper groupings, follow-on survey efforts should incorporate some collection of waterway exposure data from participants. This will not only generate information to corroborate the vessel groups used for analysis, but it will also provide some estimates of the relative importance of these groups in terms of the overall level of use of the various available NavAids in the area studied.

Follow-Up Efforts to Augment the Tampa Survey Sample for Important, Hard-to-Reach Groups of Mariners

The pilot study database includes an adequate number of responses, at least on a preliminary basis, for several categories of mariners. However, operators and pilots of large, ocean-going vessels are under-represented, relative to their share of overall port traffic. Therefore, we recommend conducting a supplemental survey participation recruitment effort in the Tampa Bay area for the purpose of augmenting the sample of selected groups of important, but hard-to-reach mariners.

The highest priority effort should be directed at increasing the number of container, cargo vessel, tanker vessel operators, and remaining harbor pilots (Vessel Group 1), followed by collection of additional data on Vessel Groups two, three, and four. Information on the total population for each group will help determine the appropriate number of responses needed for full-scale analysis.

The purpose of the follow-up campaign in the Tampa Bay area is to significantly raise survey confidence levels and reduce analysis uncertainties for the most important groups of vessels. The following steps are recommended:

1. Obtain Office of Management and Budget approval to extend the Tampa survey campaign.
2. Refine the USCG Lists of Inspected and/or Documented vessels to obtain the most useful survey participant contact data possible.
3. Collect the additional responses through means of personal interviews with vessel operators and pilots, using a paper-based survey or a mobile technology platform.
4. Analyze and refine the combined results.

Reference

XL Associates (2001). USCG Aids to Navigation (AtoN) User Survey Pilot Survey, Tampa Bay, Florida Area, Summer 2000, Survey Methodology Final Report. Unpublished work for U.S. Coast Guard Research and Development Center.

Table 2 - Vessel Characteristics by User Group

User Group/Vessel Type	Total Resp.	Beam			Draft			Length			Transit Speed			Max Speed		
		Resp.	Mean (ft)	S.D. (ft)	Resp.	Mean (ft)	S.D. (ft)	Resp.	Mean (ft)	S.D. (ft)	Resp.	Mean (ft)	S.D. (ft)	Resp.	Mean (kn)	S.D. (kn)
Large Commercial Inter-Port																
Container	1	1	47.0	-	1	31.0	-	1	950.0	-	1	22.0	-	1	23.0	-
Tanker (Refined Petroleum)	1	1	90.0	-	1	36.0	-	1	688.0	-	1	13.5	-	1	15.5	-
Tanker (Crude Oil)	1	1	200.0	-	1	35.0	-	1	100.0	-	1	16.0	-	1	24.0	-
Cruise Ship	1	1	12.0	-	1	4.0	-	1	39.0	-	1	6.0	-	1	8.0	-
Pilot	8	0	-	-	0	-	-	0	-	-	0	-	-	-	0.0	-
Large Commercial Inter-Port	12	4	87.3	81.7	4	26.5	15.2	4	669.3	441.9	4	14.4	6.6	4	17.6	7.5
Other Commercial Port-Based																
Ferry/Water Transit/Commuter	1	1	12.0	-	1	1.0	-	1	40.0	-	1	10.0	-	1	15.0	-
Harbor Cruises/Tours	4	4	15.9	5.8	4	3.9	2.4	4	46.8	17.3	4	14.0	10.8	4	20.0	20.1
Tug (Ship Assist)	4	4	35.5	15.4	4	13.0	5.5	4	86.0	31.8	4	10.0	2.4	4	12.8	3.0
Dredge	1	1	34.0	-	1	8.0	-	1	160.0	-	1	5.0	-	1	5.0	-
Salvage	2	2	8.0	0.0	2	2.0	0.0	2	21.5	2.1	2	17.5	3.5	2	23.0	4.2
Rescue	2	2	8.0	0.0	2	3.3	1.1	2	25.0	0.0	2	20.0	7.1	2	32.5	17.7
Other Commercial Port-Based	14	14	20.3	14.3	14	6.2	5.5	14	58.9	42.2	14	13.3	7.2	14	18.7	13.4
Large Commercial Port-Based																
Fishing (Gillnet)	3	3	14.7	5.1	3	3.5	2.2	3	40.2	13.4	3	13.7	9.9	3	16.5	11.0
Fishing (Trap)	5	5	21.8	30.3	5	2.3	2.1	5	23.4	8.7	5	14.7	9.1	5	22.2	10.1
Fishing (Trawl)	4	3	11.7	2.5	3	2.3	1.9	4	28.5	7.9	3	8.7	4.2	3	12.7	5.9
Large Commercial Port-Based	12	11	17.1	19.9	11	2.6	2.0	12	29.3	11.2	11	12.8	7.9	11	18.0	9.5

Resp. - Number of usable responses for the specific question. Mean - Average value across the usable responses. S.D. - Standard Deviation across the usable responses.

Table 2 - Vessel Characteristics by User Group **Continued**																
User Group/Vessel Type	**Total Resp.**	**Beam**			**Draft**			**Length**			**Transit Speed**			**Max Speed**		
		Resp.	**Mean (ft)**	**S.D. (ft)**	**Resp.**	**Mean (ft)**	**S.D. (ft)**	**Resp.**	**Mean (ft)**	**S.D. (ft)**	**Resp.**	**Mean (ft)**	**S.D. (ft)**	**Resp.**	**Mean (kn)**	**S.D. (kn)**
Other Inter-Port																
Research	4	4	10.3	3.9	4	4.3	2.9	4	29.8	11.0	4	20.3	3.3	4	23.8	5.1
USCG	6	6	23.2	12.8	6	7.4	5.7	6	120.6	83.6	6	19.7	12.4	6	28.2	18.1
Navy (Surface)	1	1	30.0	-	1	7.0	-	1	140.0	-	1	10.0	-	1.0	10	-
Marine Corps	1	1	8.0	-	1	2.0	-	1	16.0	-	1	2.0	-	1.0	30	-
State	6	5	8.0	2.3	5	2.0	0.6	6	25.7	6.8	5	25.6	8.0	5	44.4	14.7
Other Inter-Port	18	17	15.2	10.9	17	4.7	4.2	18	64.0	27.0	17	19.9	10.1	17	30.9	16.2
Tug and Barge																
Tug (Other Liquid Cargo)	1	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-
Tug and Barge	1	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-
Small Fishing/Charter																
Charter	26	25	11.9	3.2	25	3.5	1.7	25	35.4	11.9	25	16.3	6.9	25	22.8	10.6
Fishing (Hook & Line)	25	24	13.9	2.6	24	3.0	1.7	24	30.1	7.7	24	16.7	11.0	24	23.3	15.0
Fishing (Charter)	17	17	12.6	6.1	17	3.0	1.6	17	34.3	17.3	17	18.5	4.5	17	25.5	6.0
Small Fishing/Charter	68	66	12.8	9.3	66	3.2	1.7	66	33.2	12.4	66	17.0	8.1	66	23.7	11.5
Recreational Boaters																
Motor	296	251	10.3	8.0	250	3.2	3.6	291	28.0	11.0	251	21.3	7.4	251	31.7	11.2
Sail	210	185	11.3	3.0	186	4.5	1.2	208	32.4	7.3	185	5.6	1.3	186	8.3	3.5
Human Power	8	3	7.0	3.7	3	2.7	1.5	6	20.7	6.3	3	4.6	2.4	3	5.6	3.2
Recreational	3	0	-	-	0	-	-	1	23.0	-	0	-	-	0	-	-
Recreational Boaters	517	439	10.7	6.4	439	3.7	2.9	506	29.7	9.9	439	14.6	9.6	440	21.6	14.5

Resp. - Number of usable responses for the specific question. Mean - Average value across the usable responses. S.D. - Standard Deviation across the usable responses.

Table 3 - Respondent Characteristics by User Group

User Group/Vessel Type	Total Resp.	Years Operating			Has USCG License
		Resp.	Mean	S.D.	
Large Commercial Inter-Port					
Container	1	1	35.0	-	1
Tanker (Refined Petroleum)	1	1	12.0	-	1
Tanker (Crude Oil)	1	1	1.0	-	1
Cruise Ship	1	1	35.0	-	0
Pilot	8	6	28.5	3.2	7
Large Commercial Inter-Port	12	10	25.4	10.9	10
Other Commercial Port-Based					
Ferry/Water Transit/Commuter	1	1	15.0	-	1
Harbor Cruises/Tours	4	4	16.8	13	3
Tug (Ship Assist)	4	4	16.3	8.9	4
Dredge	1	1	75.0	-	0
Salvage	2	2	25.5	20.5	1
Rescue	2	2	25.0	14.1	1
Other Commercial Port-Based	14	14	23.1	18.6	10
Large Commercial Port-Based					
Fishing (Gillnet)	3	3	26.7	11.5	0
Fishing (Trap)	5	5	34.4	17.2	2
Fishing (Trawl)	4	4	37.0	15.8	1
Large Commercial Port-Based	12	12	33.3	14.7	3

Resp. - Number of usable responses for the specific question. Mean - Average value across the usable responses. S.D. - Standard Deviation across the usable responses.

Table 3 - Respondent Characteristics by User Group				Continued	
User Group/Vessel Type	**Total Resp.**	**Years Operating**			**Has USCG License**
		Resp.	**Mean**	**S.D.**	
Other Inter-Port					
Research	4	4	15.3	6.1	0
USCG	6	6	10.8	7.1	0
Navy (Surface)	1	1	20.0	-	0
Marine Corps	1	1	22.0	-	0
State	6	6	20.0	10.9	2
Other Inter-Port	18	18	16.0	8.7	2
Tug and Barge					
Tug (Other Liquid Cargo)	1	1	35.0	-	0
Tug and Barge	1	1	35.0	-	0
Small Fishing/Charter					
Charter	26	25	28.9	12.7	13
Fishing (Hook & Line)	25	25	26.4	13.5	2
Fishing (Charter)	17	17	25.8	6.4	10
Small Fishing/Charter	68	67	27.2	11.7	25
Recreational Boaters					
Motor	296	288	21.7	13.9	20
Sail	210	208	25.2	14.3	26
Human Power	8	5	27.4	18.5	0
Recreational	3	1	10.0	-	0
Recreational Boaters	517	502	23.2	14.2	46

Resp. - Number of usable responses for the specific question. Mean - Average value across the usable responses. S.D. - Standard Deviation across the usable responses.

Table 4 - Area and Conditions of Operation by User Group

(Area) →		Harbors			Inland			Narrow Channels			Near Coastal			Open Ocean		
(Visibility) →		Day	Night	R.V.	Day	Night	R.V.	Day	Night	R.V.	Day	Night	R.V.	Day	Night	R.V.
User Group/Vessel Type	**Total Resp.**															
Large Commercial Inter-Port																
Container (% pop)		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
(responses)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Tanker (Refined Petroleum)		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Tanker (Crude Oil)		100%	100%	100%	0%	0%	0%	0%	0%	0%	100%	100%	100%	100%	100%	100%
	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
Cruise Ship		100%	100%	0%	100%	100%	0%	100%	100%	0%	100%	100%	0%	100%	100%	0%
	1	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0
Pilot		100%	88%	88%	13%	13%	13%	100%	88%	88%	50%	38%	38%	25%	13%	13%
	8	8	7	7	1	1	1	8	7	7	4	3	3	2	1	1
Large Commercial Inter-Port		100%	92%	83%	33%	33%	25%	92%	83%	75%	67%	58%	50%	50%	42%	33%
	12	12	11	10	4	4	3	11	10	9	8	7	6	6	5	4
Other Commercial Port Based																
Ferry/Water Transit Commuter		100%	100%	0%	0%	0%	0%	100%	100%	0%	100%	100%	0%	0%	0%	0%
	1	1	1	0	0	0	0	1	1	0	1	1	0	0	0	0
Open Harbor Cruises/Tours		100%	75%	50%	50%	25%	25%	100%	75%	50%	50%	50%	25%	25%	25%	25%
	4	4	3	2	2	1	1	4	3	2	2	2	1	1	1	1
Tug (Ship Assist)		100%	100%	100%	75%	75%	75%	100%	100%	100%	100%	100%	100%	50%	50%	50%
	4	4	4	4	3	3	3	4	4	4	4	4	4	2	2	2
Dredge		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	0%	0%	0%
	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
Salvage		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	50%	50%	50%
	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1
Rescue		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	0%	0%	0%
	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0
Other Commercial Port Based		100%	93%	79%	71%	64%	64%	100%	93%	79%	86%	86%	71%	29%	29%	29%
	14	14	13	11	10	9	9	14	13	11	12	12	10	4	4	4

Visibility Conditions: Day = daytime, Night = nighttime, R.V. = restricted visibility

Table 4 - Area and Conditions of Operation by User Group **Continued**

(Area) →		Harbors			Inland			Narrow Channels			Near Coastal			Open Ocean		
(Visibility) →		Day	Night	R.V.	Day	Night	R.V.	Day	Night	R.V.	Day	Night	R.V.	Day	Night	R.V.
User Group/Vessel Type	**Total Resp.**															
Large Commercial Port Based																
Fishing (Gillnet) (% pop)		67%	100%	67%	67%	67%	67%	67%	100%	67%	67%	100%	67%	33%	33%	33%
(responses)	3	2	3	2	2	2	2	2	3	2	2	3	2	1	1	1
Fishing (Trap)		80%	40%	40%	60%	40%	40%	40%	20%	40%	60%	40%	40%	60%	20%	40%
	5	4	2	2	3	2	2	2	1	2	3	2	2	3	1	2
Fishing (Trawl)		50%	75%	50%	25%	25%	25%	75%	100%	75%	75%	100%	75%	50%	50%	50%
	4	2	3	2	1	1	1	3	4	3	3	4	3	2	2	2
Large Commercial Port Based		67%	67%	50%	50%	42%	42%	58%	67%	58%	67%	75%	58%	50%	33%	42%
	12	8	8	6	6	5	5	7	8	7	8	9	7	6	4	5
Other Inter-Port																
Research		75%	25%	75%	50%	25%	50%	75%	25%	75%	100%	25%	75%	50%	25%	50%
	4	3	1	3	2	1	2	3	1	3	4	1	3	2	1	2
USCG		83%	83%	83%	50%	50%	50%	83%	83%	83%	100%	100%	100%	67%	67%	67%
	6	5	5	5	3	3	3	5	5	5	6	6	6	4	4	4
Navy		0%	0%	0%	0%	0%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Marine Corps		100%	100%	0%	100%	100%	0%	100%	100%	0%	100%	100%	0%	0%	0%	0%
	1	1	1	0	1	1	0	1	1	0	1	1	0	0	0	0
State		100%	100%	100%	33%	33%	33%	83%	83%	83%	100%	100%	100%	50%	50%	50%
	6	6	6	6	2	2	2	5	5	5	6	6	6	3	3	3
Other Inter-Port		83%	72%	78%	44%	39%	39%	83%	72%	78%	100%	83%	89%	56%	50%	56%
	18	15	13	14	8	7	7	15	13	14	18	15	16	10	9	10
Tug and Barge																
Tug (Other Liquid Cargo)		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Tug and Barge		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Visibility Conditions: Day = daytime, Night = nighttime, R.V. = restricted visibility

Table 4 - Area and Conditions of Operation by User Group **Continued**

(Area) →		Harbors			Inland			Narrow Channels			Near Coastal			Open Ocean		
(Visibility) →		Day	Night	R.V.	Day	Night	R.V.	Day	Night	R.V.	Day	Night	R.V.	Day	Night	R.V.
User Group/Vessel Type	**Total Resp.**															
Small Fishing/Charter																
Charters (% pop)		69%	65%	62%	27%	27%	27%	85%	81%	77%	100%	96%	81%	65%	62%	62%
(responses)	26	18	17	16	7	7	7	22	21	20	26	25	21	17	16	16
Fishing (hook & Line)		68%	56%	48%	32%	28%	20%	80%	72%	56%	92%	80%	64%	60%	60%	48%
	25	17	14	12	8	7	5	20	18	14	23	20	16	15	15	12
Fishing (Charter)		71%	59%	47%	41%	35%	29%	82%	71%	59%	94%	82%	53%	71%	65%	47%
	17	12	10	8	7	6	5	14	12	10	16	14	9	12	11	8
Small Fishing/Charter		69%	60%	53%	32%	29%	25%	82%	75%	65%	96%	87%	68%	65%	62%	53%
	68	47	41	36	22	20	17	56	51	44	65	59	46	44	42	36
Recreational Boaters																
Motor		78%	58%	30%	49%	38%	21%	86%	67%	33%	91%	70%	34%	55%	46%	26%
	296	230	172	90	145	111	62	255	197	99	270	206	102	164	137	76
Sail		85%	69%	50%	43%	37%	30%	83%	70%	51%	96%	78%	55%	58%	51%	38%
	210	178	144	105	91	77	63	175	147	107	202	164	116	122	108	80
Human Power		75%	25%	13%	63%	25%	13%	63%	25%	13%	38%	25%	25%	13%	13%	0%
	8	6	2	1	5	2	1	5	2	1	3	2	2	1	1	0
Recreational		67%	33%	33%	67%	33%	33%	33%	33%	33%	67%	33%	33%	0%	0%	0%
	3	2	1	1	2	1	1	1	1	1	2	1	1	0	0	0
Recreational Boaters		80%	62%	38%	47%	37%	25%	84%	67%	40%	92%	72%	43%	56%	48%	30%
	517	416	319	197	243	191	127	436	347	208	477	373	221	287	246	156

Visibility Conditions: Day = daytime, Night = nighttime, R.V. = restricted visibility

Table 5 - Nav Aid Use by User Group

Nav Aid Type →		SHORT RANGE AIDS							RADIO AIDS			OTHER NAVAIDS			
User Group/ Vessel Type	**Total Resp.**	**Buoys**	**Lighted Buoys**	**Light Houses**	**Light Struct.**	**Range Markers**	**Sound Signals**	**Day Shapes**	**GPS**	**DGPS**	**LORAN**	**Background Lights**	**Celestial Features**	**Geographic Features**	**Manmade Landmarks**
Large Commercial Inter-Port															
Tanker (Refined Petroleum) (% pop)		100%	100%	100%	-	100%	-	100%	100%	100%	-	-	-	-	-
(Responses)	1	1	1	1	-	1	-	-	1	1	-	-	-	-	-
Tanker (Crude Oil)		100%	100%	-	100%	-	100%	-	-	-	-	-	-	100%	100%
	1	1	1	-	1	-	1	-	-	-	-	-	-	1	1
Cruise Ship		100%	100%	100%	100%	100%	100%	100%	100%	-	100%	-	-	100%	-
	1	1	1	1	1	1	1	1	1	-	1	-	-	1	-
Pilot		100%	100%	50%	88%	100%	25%	63%	88%	75%	-	75%	-	63%	88%
	8	8	8	4	7	8	2	5	7	6	-	6	-	5	7
Large Commercial Inter-Port		100%	100%	55%	82%	91%	36%	64%	82%	64%	9%	55%	-	64%	73%
	11	11	11	6	9	10	4	7	9	7	1	6	-	7	8
Other Commercial Port-Based															
Ferry/ Water Transit/ Commuter		100%	-	-	-	-	-	100%	100%	-	-	-	-	100%	-
	1	1	-	-	-	-	-	1	1	-	-	-	-	1	-
Harbor Cruises/ Tours		50%	100%	50%	100%	100%	50%	100%	100%	50%	50%	50%		100%	100%
	2	1	2	1	2	2	1	2	2	1	1	1	-	2	2
Tug (Ship Assist)		100%	100%	100%	100%	100%	-	100%	100%	100%	-	100%	-	100%	100%
	1	1	1	1	1	1	-	1	1	1	-	1	-	1	1
Salvage		-	-	-	-	100%	-	100%	100%	-	-	100%	-	-	-
	1	-	-	-	-	1	-	1	1	-	-	1	-	-	-
Rescue		100%	100%	100%	100%	100%	-	100%	100%	-	-	-	-	100%	100%
	1	1	1	1	1	1	-	1	1	-	-	-	-	1	1
Other Commercial Port-Based		67%	67%	50%	67%	83%	17%	100%	100%	33%	17%	50%	-	83%	67%
	6	4	4	3	4	5	1	6	6	2	1	3	-	5	4

Table 5 - Nav Aid Use by User Group **Continued**

Nav Aid Type →		SHORT RANGE AIDS							RADIO AIDS			OTHER NAVAIDS			
User Group/ Vessel Type	**Total Resp.**	**Buoys**	**Lighted Buoys**	**Light Houses**	**Light Struct.**	**Range Markers**	**Sound Signals**	**Day Shapes**	**GPS**	**DGPS**	**LORAN**	**Background Lights**	**Celestial Features**	**Geographic Features**	**Manmade Landmarks**
Large Commercial Port-Based															
Fishing (Gillnet) (% pop)		100%	100%	50%	50%	100%	-	100%	100%	-	-	50%	-	100%	100%
(Responses)	2	2	2	1	1	2	-	2	2	-	-	1	-	2	2
Fishing (Trap)		75%	75%	-	-	25%	-	25%	75%	50%	50%	50%	-	100%	75%
	4	3	3	-	-	1	-	1	3	2	2	2	-	4	3
Fishing (Trawl)		75%	100%	50%	50%	75%	-	75%	50%	25%	25%	50%	25%	100%	75%
	4	3	4	2	2	3	-	3	2	1	1	2	1	4	3
Large Commercial Port-Based		80%	90%	30%	30%	60%	-	60%	70%	30%	30%	50%	10%	100%	80%
	10	8	9	3	3	6	-	6	7	3	3	5	1	10	8
Other Inter-Port															
Research		100%	100%	33%	33%	33%	-	67%	100%	67%	-	-	-	100%	33%
	3	3	3	1	1	1	-	2	3	2	-	-	-	3	1
USCG		50%	100%	25%	50%	100%	-	75%	50%	75%		25%	50%	75%	50%
	4	2	4	1	2	4	-	3	2	3		1	2	3	2
Marine Corps		-	100%	-	-	-	-	100%	100%	-	-	-	-	100%	-
	1	-	1	-	-	-	-	1	1	-	-	-	-	1	-
State		75%	100%	25%	50%	75%	25%	100%	75%	25%	-	50%	-	100	50%
	4	3	4	1	2	3	1	4	3	1	-	2	-	4	2
Other Inter-Port		67%	100%	25%	42%	67%	8%	83%	75%	50%	-	25%	17%	92%	42%
	12	8	12	3	5	8	1	10	9	6	-	3	2	11	5

Table 5 - Nav Aid Use by User Group															**Continued**
Nav Aid Type →		**SHORT RANGE AIDS**							**RADIO AIDS**			**OTHER NAVAIDS**			
User Group/ Vessel Type	**Total Resp.**	**Buoys**	**Lighted Buoys**	**Light Houses**	**Light Struct.**	**Range Markers**	**Sound Signals**	**Day Shapes**	**GPS**	**DGPS**	**LORAN**	**Background Lights**	**Celestial Features**	**Geographic Features**	**Manmade Landmarks**
Small Fishing/Charter															
Charters (% pop)		91%	100%	48%	65%	78%	52%	74%	70%	48%	57%	48%	13%	78%	78%
(Responses)	23	21	23	11	15	18	12	17	16	11	13	11	3	18	18
Fishing (Hook & Line)		59%	82%	35%	47%	47%	24%	82%	24%	24%	59%	41%	18%	65%	65%
	17	10	14	6	8	8	4	14	4	4	10	7	3	11	11
Fishing (Charter)		86%	86%	36%	50%	71%	36%	79%	71%	29%	71%	64%	7%	86%	71%
	14	12	12	5	7	10	5	11	10	4	10	9	1	12	10
Small		80%	91%	41%	56%	67%	39%	78%	56%	35%	61%	50%	13%	76%	72%
Fishing/Charter	54	43	49	22	30	36	21	42	30	19	33	27	7	41	39
Recreational Boaters															
Motor (% pop)		81%	83%	20%	28%	42%	13%	53%	63%	20%	22%	37%	3%	78%	63%
	246	199	204	50	70	103	33	130	156	49	53	90	7	193	154
Sail		90%	90%	50%	60%	78%	40%	73%	78%	6%	24%	45%	16%	86%	73%
	176	159	159	88	106	138	70	128	138	10	43	80	28	151	129
Human Power		57%	57%	14%	14%	43%	14%	43%	29%	-	14%	29%	-	71%	71%
	7	4	4	1	1	3	1	3	2	-	1	2	-	5	5
Recreational		-	100%	100%	100%	-	-	-	100%	100%	100%	-	-	100%	100%
	1	-	1	1	1	-	-	-	1	1	1	-	-	1	1
Recreational Boaters		84%	86%	33%	41%	57%	24%	61%	69%	14%	23%	40%	8%	81%	67%
	430	362	368	140	178	244	104	261	297	60	98	172	35	350	289

Table 6A - Position Fix Frequency by User Group and Area of Operation							
Position Fix Frequency	**Total Resp.**	**Narrow Channels**	**Harbors**	**Inland**	**Near Coastal**	**Open Ocean**	**No Waterway Selected**
Large Commercial Inter-Port							
No Frequency Selected (% pop)		30%	30%	30%	-	-	10%
(Responses)	10	3	3	3	-	-	1
constantly		41%	37%	9%	11%	2%	-
	54	22	20	5	6	1	-
once every 5 minutes		18%	36%	-	36%	9%	-
	11	2	4	-	4	1	-
once every 15 minutes		-	33%	-	67%	-	-
	9	-	3	-	6	-	-
once every 30 minutes		-	-	-	-	-	-
	1	-	-	-	-	-	-
hourly		-	-	-	50%	50%	-
	4	-	-	-	2	2	-

Table 6A - Position Fix Frequency by User Group and Area of Operation							**Continued**
Position Fix Frequency	**Total Resp.**	**Narrow Channels**	**Harbors**	**Inland**	**Near Coastal**	**Open Ocean**	**No Waterway Selected**
Other Commercial Port-Based							
No Frequency Selected (% pop)		18%	29%	18%	-	6%	29%
(Responses)	17	3	5	3	-	1	5
constantly		30%	19%	16%	35%	-	-
	37	11	7	6	13	-	-
once per minute		25%	13%	38%	25%	-	-
	8	2	1	3	2	-	-
once every 5 minutes		38%	38%	13%	13%	-	-
	8	3	3	1	1	-	-
once every 15 minutes		-	40%	20%	40%	-	-
	5	-	2	1	2	-	-
once every 30 minutes		-	29%	-	57%	14%	-
	7	-	2	-	4	1	-
hourly		-	40%	20%	20%	20%	-
	5	-	2	1	1	1	-
daily		33%	-	33%	33%	-	-
	3	1	-	1	1	-	-
never		40%	-	40%	20%	-	-
	5	2	-	2	1	-	-

Table 6A - Position Fix Frequency by User Group and Area of Operation							Continued
Position Fix Frequency	**Total Resp.**	**Narrow Channels**	**Harbors**	**Inland**	**Near Coastal**	**Open Ocean**	**No Waterway Selected**
Large Commercial Port-Based							
No Frequency Selected (% pop)		33%	40%	-	20%	-	7%
(Responses)	15	5	6	-	3	-	1
constantly		31%	27%	10%	27%	6%	-
	49	15	13	5	13	3	-
once per minute		20%	-	60%	20%	-	-
	5	1	-	3	1	-	-
once every 5 minutes		-	-	-	50%	50%	-
	2	-	-	-	1	1	-
once every 15 minutes		-	-	-	50%	50%	-
	2	-	-	-	1	1	-
once every 30 minutes		-	67%	33%	-	-	-
	3	-	2	1	-	-	-
hourly		-	-	67%	25%	8%	-
	12	-	-	8	3	1	-
never		-	17%	50%	33%	-	-
	6	-	1	3	2	-	-

Table 6A - Position Fix Frequency by User Group and Area of Operation							Continued
Position Fix Frequency	**Total Resp.**	**Narrow Channels**	**Harbors**	**Inland**	**Near Coastal**	**Open Ocean**	**No Waterway Selected**
Other Inter-Port							
No Frequency Selected (% pop)		22%	39%	-	17%	-	22%
(Responses)	18	4	7	-	3	-	4
constantly		26%	24%	14%	36%	-	-
	50	13	12	7	18	-	-
once per minute		27%	30%	15%	27%	-	-
	33	9	10	5	9	-	-
once every 5 minutes		11%	-	-	56%	33%	-
	9	1	-	-	5	3	-
once every 15 minutes		14%	29%	14%	29%	14%	-
	7	1	2	1	2	1	-
once every 30 minutes		33%	17%	-	17%	33%	-
	6	2	1	-	1	2	-
hourly		-	100%	-	-	-	-
	1	-	1	-	-	-	-
daily		-	-	-	100%	-	-
	1	-	-	-	1	-	-

Table 6A - Position Fix Frequency by User Group and Area of Operation							Continued
Position Fix Frequency	**Total Resp.**	**Narrow Channels**	**Harbors**	**Inland**	**Near Coastal**	**Open Ocean**	**No Waterway Selected**
Tug and Barge		-	-	-		-	-
hourly (% pop)		-	-	-	100%	-	-
(Responses)	1	-	-	-	1	-	-
daily		-	-	-	100%	-	-
	1	-	-	-	1	-	-
never		-	-	-	100%	-	-
	1	-	-	-	1	-	-
Small Fishing/Charter							
No Frequency Selected		3%	12%	12%	39%	12%	21%
	33	1	4	4	13	4	7
constantly		30%	27%	10%	28%	5%	-
	297	90	79	30	83	15	-
once per minute		21%	19%	14%	40%	7%	-
	43	9	8	6	17	3	-
once every 5 minutes		3%	13%	13%	53%	17%	-
	30	1	4	4	16	5	-
once every 15 minutes		-	-	6%	71%	24%	-
	17	-	-	1	12	4	-
once every 30 minutes		-	-	-	80%	20%	-
	5	-	-	-	4	1	-
hourly		6%	-	6%	75%	13%	-
	16	1	-	1	12	2	-
daily		19%	10%	5%	67%	-	-
	21	4	2	1	14	-	-
never		38%	28%	24%	10%	-	-
	29	11	8	7	3	-	-

Table 6A - Position Fix Frequency by User Group and Area of Operation							**Continued**
Position Fix Frequency	**Total Resp.**	**Narrow Channels**	**Harbors**	**Inland**	**Near Coastal**	**Open Ocean**	**No Waterway Selected**
Recreational Boaters							
No Frequency Selected (% pop)		19%	26%	13%	18%	12%	11%
(Responses)	257	50	68	34	46	32	27
constantly		34%	26%	15%	25%	1%	-
	1785	598	457	266	444	20	-
once per minute		22%	24%	16%	35%	3%	-
	349	78	84	55	123	9	-
once every 5 minutes		13%	24%	17%	38%	8%	-
	393	53	95	66	149	30	-
once every 15 minutes		4%	12%	11%	53%	20%	-
	255	11	31	28	134	51	-
once every 30 minutes		1%	15%	7%	52%	25%	-
	151	2	22	11	78	38	-
hourly		2%	7%	9%	40%	43%	-
	138	3	9	12	55	59	-
daily		10%	16%	18%	39%	18%	-
	51	5	8	9	20	9	-
never		21%	23%	19%	35%	2%	-
	122	26	28	23	43	2	-

Table 6A - Position Fix Frequency by User Group and Area of Operation							Continued
Position Fix Frequency	**Total Resp.**	**Narrow Channels**	**Harbors**	**Inland**	**Near Coastal**	**Open Ocean**	**No Waterway Selected**
No Vessel Type Selected							
No Frequency Selected (% pop)		12%	17%	17%	29%	7%	17%
(Responses)	58	7	10	10	17	4	10
constantly		36%	22%	18%	22%	3%	-
	101	36	22	18	22	3	-
once per minute		21%	29%	21%	29%	-	-
	14	3	4	3	4	-	-
once every 5 minutes		19%	19%	19%	31%	12%	-
	26	5	5	5	8	3	-
once every 15 minutes		6%	18%	18%	29%	29%	-
	17	1	3	3	5	5	-
once every 30 minutes		-	25%	50%	25%	-	-
	4	-	1	2	1	-	-
hourly		12%	12%	12%	41%	24%	-
	17	2	2	2	7	4	-
daily		-	-	-	100%	-	-
	1	-	-	-	1	-	-
never		13%	31%	19%	38%	-	-
	32	4	10	6	12	-	-

Table 6B - Position Fix Accuracy by User Group and Waterway Type							
Position Fix Accuracy	**Total Resp.**	**Narrow Channels**	**Harbors**	**Inland**	**Near Coastal**	**Open Ocean**	**No Waterway Selected**
Large Commercial Inter-Port							
No Accuracy Selected(% pop)		30%	30%	30%	-	-	10%
(Responses)	10	3	3	3	-	-	1
within 2 yards or less		36%	28%	8%	24%	4%	-
	25	9	7	2	6	1	-
within 10 yards		39%	50%	-	7%	4%	-
	28	11	14	-	2	1	-
within 50 yards		22%	33%	17%	22%	6%	-
	18	4	6	3	4	1	-
within 100 yards		-	-	-	86%	14%	-
	7	-	-	-	6	1	-
within 1 nautical mile		-	-	-	-	100%	-
	1	-	-	-	-	1	-

Table 6B - Position Fix Accuracy by User Group and Waterway Type **Continued**							
Position Fix Accuracy	**Total Resp.**	**Narrow Channels**	**Harbors**	**Inland**	**Near Coastal**	**Open Ocean**	**No Waterway Selected**
Other Commercial Port-Based							
No Accuracy Selected (% pop)		18%	29%	18%	-	6%	29%
(Responses)	17	3	5	3	-	1	5
within 2 yards or less		61%	22%	-	17%	-	-
	18	11	4	-	3	-	-
within 10 yards		12%	24%	35%	29%	-	-
	34	4	8	12	10	-	-
within 50 yards		20%	20%	-	60%	-	-
	5	1	1	-	3	-	-
within 100 yards		-	20%	-	60%	20%	-
	5	-	1	-	3	1	-
within 1000 yards		-	25%	-	50%	25%	-
	4	-	1	-	2	1	-
within 1 nautical mile		25%	17%	25%	33%	-	-
	12	3	2	3	4	-	-

Table 6B - Position Fix Accuracy by User Group and Waterway Type						Continued	
Position Fix Accuracy	**Total Resp.**	**Narrow Channels**	**Harbors**	**Inland**	**Near Coastal**	**Open Ocean**	**No Waterway Selected**
Large Commercial Port-Based							
No Accuracy Selected (% pop)		33%	33%	-	28%	-	6%
(Responses)	18	6	6	-	5	-	1
within 2 yards or less		33%	11%	17%	33%	6%	-
	18	6	2	3	6	1	-
within 10 yards		25%	28%	14%	25%	8%	-
	36	9	10	5	9	3	-
within 50 yards		-	33%	33%	-	33%	-
	3	-	1	1	-	1	-
within 100 yards		-	15%	62%	23%	-	-
	13	-	2	8	3	-	-
within 1000 yards		-	-	-	100%	-	-
	1	-	-	-	1	-	-
within 1 nautical mile		-	-	-	-	100%	-
	1	-	-	-	-	1	-
within 5 nautical miles		-	25%	75%	-	-	-
	4	-	1	3	-	-	-

Table 6B - Position Fix Accuracy by User Group and Waterway Type						Continued	
Position Fix Accuracy	**Total Resp.**	**Narrow Channels**	**Harbors**	**Inland**	**Near Coastal**	**Open Ocean**	**No Waterway Selected**
Other Inter-Port							
No Accuracy Selected (% pop)		18%	41%	-	18%	-	24%
(Responses)	17	3	7	-	3	-	4
within 2 yards or less		26%	26%	17%	30%	2%	-
	54	14	14	9	16	1	-
within 10 yards		40%	23%	10%	23%	3%	-
	30	12	7	3	7	1	-
within 50 yards		-	29%	6%	53%	12%	-
	17	-	5	1	9	2	-
within 100 yards		-	-	-	80%	20%	-
	5	-	-	-	4	1	-
within 1 nautical mile		-	-	-	-	100%	-
	1	-	-	-	-	1	-
within 5 nautical miles		100%	-	-	-	-	-
	1	1	-	-	-	-	-
Tug and Barge							
No Accuracy Selected (% pop)		-	-	-	100%	-	-
(Responses)	1	-	-	-	1	-	-
within 10 yards		-	-	-	100%	-	-
	1	-	-	-	1	-	-
within 50 yards		-	-	-	100%	-	-
	1	-	-	-	1	-	-

Table 6B - Position Fix Accuracy by User Group and Waterway Type						Continued	
Position Fix Accuracy	**Total Resp.**	**Narrow Channels**	**Harbors**	**Inland**	**Near Coastal**	**Open Ocean**	**No Waterway Selected**
Small Fishing/Charter							
No Accuracy Selected (% pop)		14%	20%	18%	27%	8%	14%
(Responses)	51	7	10	9	14	4	7
within 2 yards or less		32%	17%	10%	35%	6%	-
	188	60	32	19	66	11	-
within 10 yards		24%	27%	10%	35%	3%	-
	186	45	50	19	66	6	-
within 50 yards		5%	32%	11%	43%	8%	-
	37	2	12	4	16	3	-
within 100 yards		-	8%	23%	46%	23%	-
	13	-	1	3	6	3	-
within 1000 yards		-	-	-	33%	67%	-
	3	-	-	-	1	2	-
within 1 nautical mile		-	-	-	50%	50%	-
	8	-	-	-	4	4	-
within 5 nautical miles		60%	-	-	20%	20%	-
	5	3	-	-	1	1	-

Table 6B - Position Fix Accuracy by User Group and Waterway Type						Continued	
Position Fix Accuracy	**Total Resp.**	**Narrow Channels**	**Harbors**	**Inland**	**Near Coastal**	**Open Ocean**	**No Waterway Selected**
Recreational Boaters							
No Accuracy Selected (% pop)		21%	23%	14%	24%	10%	8%
(Responses)	345	74	81	47	83	33	27
within 2 yards or less		43%	24%	14%	18%	1%	-
	814	349	194	111	150	10	-
within 10 yards		25%	26%	16%	31%	2%	-
	1366	337	356	219	425	29	-
within 50 yards		10%	22%	16%	44%	8%	-
	469	49	101	77	205	37	-
within 100 yards		3%	17%	11%	51%	18%	-
	286	9	48	32	145	52	-
within 1000 yards		4%	11%	8%	49%	28%	-
	102	4	11	8	50	29	-
within 1 nautical mile		1%	5%	7%	27%	60%	-
	92	1	5	6	25	55	-
within 5 nautical miles		11%	22%	15%	33%	19%	-
	27	3	6	4	9	5	-

Table 6B - Position Fix Accuracy by User Group and Waterway Type						Continued	
Position Fix Accuracy	**Total Resp.**	**Narrow Channels**	**Harbors**	**Inland**	**Near Coastal**	**Open Ocean**	**No Waterway Selected**
No Vessel Type Selected							
No Accuracy Selected (% pop)		12%	19%	17%	36%	5%	12%
(Responses)	86	10	16	15	31	4	10
within 2 yards or less		37%	28%	17%	17%	2%	-
	54	20	15	9	9	1	-
within 10 yards		23%	23%	26%	26%	3%	-
	70	16	16	18	18	2	-
within 50 yards		32%	24%		32%	12%	-
	25	8	6		8	3	-
within 100 yards		6%	6%	38%	19%	31%	-
	16	1	1	6	3	5	-
within 1000 yards		23%	23%	8%	46%	-	-
	13	3	3	1	6	-	-
within 1 nautical mile		-	-	-	-	100%	-
	3	-	-	-	-	3	-
within 5 nautical miles		-	-	-	67%	33%	-
	3	-	-	-	2	1	-

Table 7A - NavAid Preference by User Group - All Conditions															
Nav Aid Type →	**SHORT RANGE AIDS**							**RADIO AIDS**			**OTHER NAVAIDS**				
User Group/ Vessel Type	**Buoys**	**Lighted Buoys**	**Light Struct.**	**Range Markers**	**RACON**	**Sound Signals**	**Day Shapes**	**GPS**	**DGPS**	**LORAN**	**Background Lights**	**Celestial Features**	**Geographic Features**	**Manmade Landmarks**	
Large Commercial Inter-Port															
Tanker (Refined Petroleum) (% pop)	-	-	58%	17%	-	-	8%	17%	-	-	-	-	-		
(responses)	-	-	-	7	2	-	-	1	2	-	-	-	-	-	
Tanker (Crude Oil)	-	43%	-	-	-	-	-	14%	-	-	-	-	43%	-	
	-	3	-	-	-	-	-	1	-	-	-	-	3	-	
Cruise Ship	11%	22%	-	11%	-	-	-	-	-	11%	11%	-	33%	-	
	1	2	-	1	-	-	-	-	-	1	1	-	3	-	
Pilot	10%	10%	-	54%	-	-	3%	5%	12%	-	-	-	5%	-	
	6	6	-	32	-	-	2	3	7	-	-	-	3	-	
Large Commercial Inter-Port	8%	13%	-	46%	2%	-	2%	6%	10%	1%	1%	-	10%	-	
	7	11	-	40	2	-	2	5	9	1	1	-	9	-	
Other Commercial Port-Based															
Ferry Water Transit/Commuter	-	33%	-	-	-	-	-	-	-	-	-	-	67%	-	
	-	1	-	-	-	-	-	-	-	-	-	-	2	-	
Harbor Cruises/Tours	16%	21%	-	-	-	-	16%	5%	5%	-	-	-	37%	-	
	3	4	-	-	-	-	3	1	1	-	-	-	7	-	
Tug (Ship Assist)	8%	12%	-	36%	-	-	12%	4%	8%	-	-	-	16%	4%	
	2	3	-	9	-	-	3	1	2	-	-	-	4	1	
Dredge	-	-	33%	33%	-	-	-	-	33%	-	-	-	-	-	
	-	-	1	1	-	-	-	-	1	-	-	-	-	-	
Salvage	-	18%	-	-	-	27%	18%	36%	-	-	-	-	-	-	
	-	2	-	-	-	3	2	4	-	-	-	-	-	-	
Rescue	38%	-	-	-	-	-	-	50%	-	-	-	-	13%	-	
	3	-	-	-	-	-	-	4	-	-	-	-	1	-	
Other Commercial Port-Based	12%	14%	1%	14%	-	4%	12%	14%	6%	-	-	-	20%	1%	
	8	10	1	10	-	3	8	10	4	-	-	-	14	1	

Table 7A - NavAid Preference by User Group - All Conditions															**Continued**
Nav Aid Type →	**SHORT RANGE AIDS**							**RADIO AIDS**			**OTHER NAVAIDS**				
User Group/ Vessel Type	**Buoys**	**Lighted Buoys**	**Light Struct.**	**Range Markers**	**RACON**	**Sound Signals**	**Day Shapes**	**GPS**	**DGPS**	**LORAN**	**Background Lights**	**Celestial Features**	**Geographic Features**	**Manmade Landmarks**	
Large Commercial Port-Based															
Fishing (Gillnet)	15%	4%	-	-	-	-	8%	65%	-	-	-	-	8%	-	
	4	1	-	-	-	-	2	17	-	-	-	-	2	-	
Fising (Trap)	19%	33%	-	-	-	-	5%	33%	5%	-	-	-	-	5%	
	4	7	-	-	-	-	1	7	1	-	-	-	-	1	
Fishing (Trawl)	17%	37%	3%	-	-	-	3%	3%	20%	-	3%	-	10%	3%	
	5	11	1	-	-	-	1	1	6	-	1	-	3	1	
Large Commercial Port-Based	17%	25%	1%	-	-	-	5%	32%	9%	-	1%	-	6%	3%	
	13	19	1	-	-	-	4	25	7	-	1	-	5	2	
Other Inter-Port															
Research	36%	14%	-	-	-	-	-	21%	25%	-	-	-	4%		
	10	4	-	-	-	-	-	6	7	-	-	-	1	-	
USCG	-	2%	2%	20%	-	7%	14%	5%	23%	-	2%	-	11%	14%	
	-	1	1	9	-	3	6	2	10	-	1	-	5	6	
Navy (Surface)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Marine Corps	-	-	50%	-	-	-	-	25%	-	-	13%	-	-	13%	
	-	-	4	-	-	-	-	2	-	-	1	-	-	1	
State	6%	14%	-	3%	6%	8%	14%	33%	-	-	-	-	14%	3%	
	2	5	-	1	2	3	5	12	-	-	-	-	5	1	
Other Inter-Port	10%	9%	4%	9%	2%	5%	9%	19%	15%	-	2%	-	9%	7%	
	12	10	5	10	2	6	11	22	17	-	2	-	11	8	
Tug and Barge															
Tug(Other Liquid Cargo)	-	-	-	-	-	-	-	100%	-	-	-	-	-	-	
	-	-	-	-	-	-	-	2	-	-	-	-	-	-	
Tug and Barge	-	-	-	-	-	-	-	100%	-	-	-	-	-	-	
	-	-	-	-	-	-	-	2	-	-	-	-	-	-	

Table 7A - NavAid Preference by User Group - All Conditions															**Continued**
Nav Aid Type ⟶	**SHORT RANGE AIDS**							**RADIO AIDS**			**OTHER NAVAIDS**				
User Group/ Vessel Type	**Buoys**	**Lighted Buoys**	**Light Struct.**	**Range Markers**	**RACON**	**Sound Signals**	**Day Shapes**	**GPS**	**DGPS**	**LORAN**	**Background Lights**	**Celestial Feautures**	**Geographic Features**	**Manmade Landmarks**	
Small Fishing/Charter															
Charters	12%	18%	2%	-	-	-	4%	13%	26%	11%	-	-	10%	4%	
	24	36	4	-	-	-	8	26	54	22	-	-	21	9	
Fishing(Hook & Line)	16%	9%	1%	3%	-	2%	4%	12%	25%	11%	1%	-	8%	8%	
	21	12	1	4	-	3	5	16	32	14	1	-	11	10	
Fishing (Charter)	13%	21%	-	1%	2%	-	12%	24%	16%	6%	-	1%	4%	1%	
	13	22	-	1	2	-	12	25	16	6	-	1	4	1	
Small Fishing/Charter	13%	16%	1%	1%	0%	1%	6%	15%	23%	10%	0%	0%	8%	5%	
	58	70	5	5	2	3	25	67	102	42	1	1	36	20	
Recreational Boaters															
Motor	25%	16%	2%	2%	-	2%	7%	20%	14%	4%	1%	0%	5%	3%	
	429	272	26	28	-	31	123	347	232	70	15	8	81	50	
Sail	24%	15%	3%	2%	0%	3%	12%	30%	2%	2%	1%	1%	5%	2%	
	331	208	40	31	1	39	163	420	26	26	9	10	75	28	
Human Power	4%	-	-	-	-	-	8%	38%	-	-	-	17%	21%	13	
	1	-	-	-	-	-	2	9	-	-	-	4	5	3	
Recreational	25%	-	-	-	-	-	-	25%	-	-	-	50%	-	-	
	1	-	-	-	-	-	-	1	-	-	-	2	-	-	
Recreational Boaters	24%	15%	2%	2%	0%	2%	9%	25%	8%	3%	1%	1%	5%	3%	
	762	480	66	59	1	70	288	777	256	96	24	24	161	81	

Table 7B - Who Prefers Which NavAid By Restricted Visibility														
Nav Aid Type →	**SHORT RANGE AIDS**							**RADIO AIDS**			**OTHER NAVAIDS**			
User Group/ Vessel Type	**Buoys**	**Lighted Buoys**	**Light Struct.**	**Range Markers**	**RACON**	**Sound Signals**	**Day Shapes**	**GPS**	**DGPS**	**LORAN**	**Background Lights**	**Celestial Features**	**Geographic Features**	**Manmade Landmarks**
Large Commercial Inter-Port														
Tanker (Refined Petroleum)	-	-	-	-	67%	-	-	-	33%	-	-	-	-	-
	-	-	-	-	2	-	-	-	1	-	-	-	-	-
Tanker (Crude Oil)	-	100	-		-	-	-	-	-	-	-	-	-	-
	-	2	-		-	-	-	-	-	-	-	-	-	-
Pilot	28%	28%	-	11%	-	-	-	-	28%	-	-	-	6%	-
	5	5	-	2	-	-	-	-	5	-	-	-	1	-
Large Commercial Inter-Port	22%	30%	-	9%	9%	-	-	-	26%	-	-	-	4%	-
	5	7	-	2	2	-	-	-	6	-	-	-	1	-
Other Commercial Inter-Port														
Harbor Cruises/Tours	-	-	-	-	-	-	-	-	-	-	-	-	100%	-
	-	-	-	-	-	-	-	-	-	-	-	-	4	-
Tug (Ship Assist)	-	25%	-	13%	-	-	13%	-	13%	-	-	-	38%	-
	-	2	-	1	-	-	1	-	1	-	-	-	3	-
Dredge	-	-	-	-	-	-	-	-	100%	-	-	-	-	-
	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Salvage	-	-	-	-	-	100%	-	-	-	-	-	-	-	-
	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Rescue	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other Commercial Inter-Port	-	14%	-	7%	-	7%	7%	-	14%	-	-	-	50%	-
	-	2	-	1	-	1	1	-	2	-	-	-	7	-

Table 7B - Who Prefers Which NavAid By Restricted Visibility															**Continued**
Nav Aid Type →	**SHORT RANGE AIDS**							**RADIO AIDS**			**OTHER NAVAIDS**				
User Group/ Vessel Type	**Buoys**	**Lighted Buoys**	**Light Struct.**	**Range Markers**	**RACON**	**Sound Signals**	**Day Shapes**	**GPS**	**DGPS**	**LORAN**	**Background Lights**	**Celestial Features**	**Geographic Features**	**Manmade Landmarks**	
Large Commercial Port-Based															
Fishing (Gillnet)	-	-	-	-	-	-	-	86%	-	-	-	-	14%	-	
	-	-	-	-	-	-	-	6	-	-	-	-	1	-	
Fising (Trap)	-	80%	-	-	-	-	-	20%	-	-	-	-	-	-	
	-	4	-	-	-	-	-	1	-	-	-	-	-	-	
Fishing (Trawl)	-	44%	-	-	-	-	-	-	33%	-	11%	-	11%	-	
	-	4	-	-	-	-	-	-	3	-	1	-	1	-	
Large Commercial Port-Based	-	38%	-	-	-	-	-	33%	14%	-	5%	-	10%	-	
	-	8	-	-	-	-	-	7	3	-	1	-	2	-	
Other Inter-Port															
Research	27%	-	-	-	-	-	-	27%	45%	-	-	-	-	-	
	3	-	-	-	-	-	-	3	5	-	-	-	-	-	
USCG	-	7%	-	-	-	21%	-	-	57%	-	-	-	14%	-	
	-	1	-	-	-	3	-	-	8	-	-	-	2	-	
Navy (Surface)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
State	-	9%	-	-	9%	18%	9%	45%	-	-	-	-	9%	-	
	-	1	-	-	1	2	1	5	-	-	-	-	1	-	
Other Inter-Port	8%	6%	-	-	3%	14%	3%	22%	36%	-	-	-	8%	-	
	3	2	-	-	1	5	1	8	13	-	-	-	3	-	
Tug and Barge															
Tug(Other Liquid Cargo)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Tug and Barge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Table 7B - Who Prefers Which NavAid By Restricted Visibility															**Continued**
Nav Aid Type →	**SHORT RANGE AIDS**							**RADIO AIDS**			**OTHER NAVAIDS**				
User Group/ Vessel Type	**Buoys**	**Lighted Buoys**	**Light Struct.**	**Range Markers**	**RACON**	**Sound Signals**	**Day Shapes**	**GPS**	**DGPS**	**LORAN**	**Background Lights**	**Celestial Features**	**Geographic Features**	**Manmade Landmarks**	
Small Fishing/Charter															
Charters	7%	16%	2%	-	-	-	3%	14%	28%	12%	-	-	16%	3%	
	4	9	1	-	-	-	2	8	16	7	-	-	9	2	
Fishing(Hook & Line)	10%	10%	-	3%	-	6%	-	13%	35%	16%	-	-	3%	3%	
	3	3	-	1	-	2	-	4	11	5	-	-	1	1	
Fishing (Charter)	22%	22%	-	-	9%	-	-	17%	22%	9%	-	-	-	-	
	5	5	-	-	2	-	-	4	5	2	-	-	-	-	
Small Fishing/Charter	11%	15%	1%	1%	2%	2%	2%	14%	29%	13%	-	-	9%	3%	
	12	17	1	1	2	2	2	16	32	14	-	-	10	3	
Recreational Boaters															
Motor	12%	19%	1%	0%	-	4%	3%	23%	21%	9%	2%	-	3%	2%	
	33	50	2	1	-	11	8	62	56	24	6	-	9	4	
Sail	13%	15%	1%	2%	-	6%	8%	44%	2%	2%	0%	0%	5%	2%	
	39	44	3	5	-	19	23	131	5	7	1	1	14	5	
Human Power	-	-	-	-	-	-	-	80%	-	-	-	20%	-	-	
	-	-	-	-	-	-	-	4	-	-	-	1	-	-	
Recreational	-	-	-	-	-	-	-	-	-	-	-	100%	-	-	
	-	-	-	-	-	-	-	-	-	-	-	1	-	-	
Recreational Boaters	13%	17%	1%	1%	-	5%	5%	35%	11%	5%	1%	1%	4%	2%	
	72	94	5	6	-	30	31	197	61	31	7	3	23	9	

Table 8A -Most Preferred NavAid by Visibility and Area of Operation - All Respondents

Area	Harbors				Inland				Narrow Channels				Near Coastal				Open Ocean
Visibility	**Day**	**Night**	**R.V.**	**Total**	**Day**	**Night**	**R.V.**	**Total**	**Day**	**Night**	**R.V.**	**Total**	**Day**	**Night**	**R.V.**	**Total**	**Total**
Nav Aid Category/Type																	
Short Range																	
Buoy	44%	19%	12%	29%	32%	18%	12%	23%	46%	15%	20%	30%	26%	8%	6%	15%	xx
Buoy Lighted	3%	39%	23%	20%	2%	28%	14%	13%	3%	42%	22%	20%	3%	24%	7%	11%	xx
Daymarker	13%	3%	4%	8%	14%	5%	7%	10%	20%	7%	7%	13%	13%	6%	3%	8%	xx
Light Structure	1%	3%	0%	2%	1%	6%	1%	3%	1%	3%	0%	2%	2%	4%	2%	3%	xx
RACON	0%	1%	1%	1%	0%	0%	2%	0%	0%	0%	1%	0%	0%	0%	1%	0%	xx
Range Marker	5%	4%	1%	4%	4%	4%	2%	4%	5%	5%	3%	5%	4%	2%	0%	3%	xx
Sound	1%	1%	5%	2%	1%	2%	7%	3%	2%	1%	2%	2%	2%	2%	5%	2%	xx
Radio																	
DGPS	5%	7%	14%	8%	6%	9%	15%	9%	5%	7%	11%	7%	8%	9%	16%	10%	23%
GPS	10%	14%	24%	14%	16%	21%	26%	20%	7%	12%	20%	11%	23%	33%	43%	31%	63%
Loran	1%	1%	5%	2%	1%	1%	4%	2%	1%	1%	4%	2%	5%	5%	9%	6%	12%
Other																	
Background Lights	0%	2%	0%	1%	0%	2%	2%	1%	0%	0%	0%	0%	0%	2%	2%	1%	xx
Celestial Features	0%	0%	0%	0%	1%	1%	0%	1%	0%	0%	0%	0%	1%	1%	1%	1%	2%
Geographic Features	9%	5%	6%	7%	15%	4%	7%	10%	5%	5%	7%	5%	10%	2%	5%	6%	xx
Manmade Landmarks	6%	2%	2%	4%	4%	1%	2%	3%	4%	3%	2%	3%	5%	2%	0%	3%	xx
Total Responses	440	328	206	974	268	199	121	588	451	349	215	1015	610	483	287	1380	309

R.V. = Restricted Visibility Total = Total percentage for that navigation area and aid type

Percentages shown are the percentage of responses per category and NavAid type. xx = Short range NavAids and most others were not options for Open Ocean

Table 8B - Most Preferred NavAid by Visibility and Area of Operation - Commercial/Public Vessels

Area	**Harbors**				**Inland**				**Narrow Channels**				**Near Coastal**				**Open Ocean**
Visibility	**Day**	**Night**	**R.V.**	**Total**	**Day**	**Night**	**R.V.**	**Total**	**Day**	**Night**	**R.V.**	**Total**	**Day**	**Night**	**R.V.**	**Total**	**Total**
Nav Aid Category/Type																	
Short Range																	
Buoy	31%	3%	11%	16%	35%	0%	8%	16%	15%	3%	12%	10%	16%	3%	3%	8%	**xx**
Buoy Lighted	3%	28%	19%	16%	0%	29%	33%	18%	3%	21%	19%	14%	3%	24%	17%	14%	**xx**
Daymarker	14%	6%	4%	8%	0%	0%	0%	0%	18%	7%	0%	9%	14%	9%	3%	9%	**xx**
Light Structure	3%	6%	0%	3%	0%	6%	0%	2%	0%	0%	0%	0%	0%	9%	0%	3%	**xx**
RACON	0%	3%	4%	2%	0%	0%	0%	0%	0%	0%	8%	2%	0%	0%	0%	0%	**xx**
Range Marker	22%	28%	4%	19%	25%	24%	0%	18%	30%	34%	8%	25%	14%	18%	0%	11%	**xx**
Sound	0%	0%	7%	2%	0%	0%	8%	2%	0%	0%	0%	0%	3%	6%	10%	6%	**xx**
Radio																	
DGPS	0%	0%	26%	7%	0%	0%	17%	4%	3%	7%	23%	10%	5%	3%	31%	12%	35%
GPS	11%	13%	15%	13%	25%	35%	17%	27%	9%	7%	12%	9%	16%	21%	21%	19%	60%
Loran	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	5%
Other																	
Background Lights	0%	0%	0%	0%	0%	6%	0%	2%	0%	3%	0%	1%	3%	0%	3%	2%	**xx**
Celestial Features	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Geographic Features	14%	6%	11%	11%	5%	0%	17%	6%	12%	10%	19%	14%	24%	6%	10%	14%	**xx**
Manmade Landmarks	3%	6%	0%	3%	10%	0%	0%	4%	9%	7%	0%	6%	3%	0%	0%	1%	**xx**
Total Responses	**36**	**32**	**27**	**95**	**20**	**17**	**12**	**49**	**33**	**29**	**26**	**88**	**37**	**33**	**29**	**99**	**20**

Excludes small fishing/charter vessels. R.V. = Restricted Visibility Total = Total percentage for that navigation area and aid type

Percentages shown are the percentage of responses per category and NavAid type. xx = Short range NavAids and most others were not options for Open Ocean

Table 8C -Most Preferred NavAid by Visibility and Area of Operation – Small Fishing/Charter Vessels																	
Area	**Harbors**				**Inland**				**Narrow Channels**				**Near Coastal**				**Open Ocean**
Visibility	**Day**	**Night**	**R.V.**	**Total**	**Day**	**Night**	**R.V.**	**Total**	**Day**	**Night**	**R.V.**	**Total**	**Day**	**Night**	**R.V.**	**Total**	**Total**
Nav Aid Category/Type																	
Short Range																	
Buoy	29%	10%	14%	19%	16%	0%	9%	9%	37%	11%	12%	21%	13%	2%	7%	7%	xx
Buoy Lighted	5%	48%	21%	24%	0%	33%	9%	13%	5%	39%	26%	23%	2%	26%	7%	11%	xx
Daymarker	13%	0%	0%	5%	11%	0%	0%	4%	16%	0%	3%	7%	16%	2%	2%	7%	xx
Light Structure	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	5%	2%	3%	xx
RACON	0%	0%	0%	0%	0%	0%	9%	2%	0%	0%	0%	0%	0%	0%	2%	1%	xx
Range Marker	3%	0%	0%	1%	0%	0%	0%	0%	5%	3%	3%	3%	0%	0%	0%	0%	xx
Sound	0%	0%	4%	1%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	2%	1%	xx
Radio																	
DGPS	18%	23%	32%	24%	11%	20%	18%	16%	14%	21%	26%	20%	16%	17%	26%	19%	50%
GPS	8%	6%	7%	7%	21%	27%	18%	22%	9%	16%	12%	12%	13%	16%	17%	15%	32%
Loran	3%	3%	11%	5%	5%	0%	9%	4%	2%	3%	6%	3%	22%	22%	28%	24%	18%
Other																	
Background Lights	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	1%	xx
Celestial Features	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	1%	0%
Geographic Features	18%	6%	7%	11%	32%	13%	27%	24%	5%	0%	6%	3%	9%	3%	7%	7%	xx
Manmade Landmarks	3%	3%	4%	3%	5%	7%	0%	4%	7%	8%	6%	7%	8%	3%	0%	4%	xx
Total Responses	38	31	28	97	19	15	11	45	43	38	34	115	64	58	46	168	34

R.V. = Restricted Visibility Total = Total percentage for that navigation area and aid type

Percentages shown are the percentage of responses per category and NavAid type. xx = Short range NavAids and most others were not options for Open Ocean

Table 8D - Most Preferred NavAid by Visibility and Area of Operation - Recreational Vessels

Area	Harbors				Inland				Narrow Channels				Near Coastal				Open Ocean
Visibility	**Day**	**Night**	**R.V.**	**Total**	**Day**	**Night**	**R.V.**	**Total**	**Day**	**Night**	**R.V.**	**Total**	**Day**	**Night**	**R.V.**	**Total**	**Total**
Nav Aid Category/Type																	
Short Range																	
Buoy	47%	22%	12%	32%	33%	21%	11%	25%	50%	16%	22%	33%	28%	8%	6%	17%	xx
Buoy Lighted	2%	40%	25%	20%	2%	28%	13%	13%	3%	45%	23%	22%	3%	24%	7%	11%	xx
Daymarker	13%	3%	3%	8%	16%	5%	9%	11%	21%	7%	8%	14%	13%	6%	3%	8%	xx
Light Structure	1%	3%	1%	2%	2%	6%	1%	3%	2%	4%	1%	2%	1%	3%	1%	2%	xx
RACON	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	xx
Range Marker	3%	1%	1%	2%	3%	1%	1%	2%	3%	2%	2%	2%	3%	1%	0%	2%	xx
Sound	1%	1%	5%	2%	2%	3%	9%	4%	2%	2%	3%	2%	2%	2%	5%	2%	xx
Radio																	
DGPS	5%	7%	9%	6%	6%	9%	16%	9%	5%	4%	6%	5%	7%	9%	13%	9%	19%
GPS	11%	15%	29%	16%	16%	19%	29%	19%	7%	12%	23%	12%	26%	37%	52%	35%	67%
Loran	1%	1%	6%	2%	1%	1%	3%	2%	1%	0%	5%	2%	3%	3%	7%	4%	11%
Other																	
Background Lights	1%	2%	1%	1%	0%	1%	2%	1%	0%	0%	0%	0%	0%	2%	2%	1%	xx
Celestial Features	0%	0%	0%	0%	1%	1%	0%	1%	0%	0%	0%	0%	1%	2%	2%	1%	2%
Geographic Features	8%	4%	5%	6%	15%	3%	3%	8%	4%	4%	5%	4%	8%	1%	3%	5%	xx
Manmade Landmarks	7%	1%	3%	4%	3%	1%	2%	2%	3%	1%	1%	2%	4%	2%	1%	3%	xx
Total Responses	340	250	143	733	211	154	90	455	350	267	147	764	471	370	200	1041	236

R.V. = Restricted Visibility Total = Total percentage for that navigation area and aid type

Percentages shown are the percentage of responses per category and NavAid type. xx = Short range NavAids and most others were not options for Open Ocean

Table 9 - Primary NavAid Preferences by User Group

User Group/Vessel Type	# of Respondents in each User Group who selected: SRA as Primary NavAids	RA as Primary NavAids	Non-USCG NavAids	Even Distribution of NavAids
Large Commercial Inter-Port				
Tanker (Refined Petroleum)	1	0	0	0
Tanker (Crude Oil)	0	0	0	1
Cruise Ship	0	0	0	1
Other Commercial Port-Based				
Ferry/ Water Transit/ Commuter	0	0	0	1
Harbor Cruises/ Tours	0	0	0	2
Tug (Ship Assist)	2	0	0	0
Dredge	1	0	0	0
Salvage	2	0	0	0
Rescue	0	0	0	1
Large Commercial Port-Based				
Fishing (Gillnet)	2	0	0	1
Fishing (Trap)	0	1	0	3
Fishing (Trawl)	3	0	0	1
Other Inter-Port				
Research	1	0	0	2
USCG	2	0	0	2
Marine Corps	0	0	0	1
State	3	0	0	2
Tug and Barge				
Tug & Barge (Other Liquid Cargo)	1	0	0	0

Table 9 - Primary NavAid Preferences by User Group **Continued**

User Group/Vessel Type	# of Respondents in each User Group who selected: SRA as Primary NavAids	RA as Primary NavAids	Non-USCG NavAids	Even Distribution of NavAids
Small Fishing/Charter				
Charters	3	5	2	13
Fishing (Hook & Line)	4	5	3	10
Fishing (Charter)	4	5	0	7
Recreational Boaters				
Motor	104	18	34	119
Sail	104	5	13	77
Human Power	0	0	5	3
Recreational	1	1	1	0